quarterly analysis review

15.1
1Q 2015

vto	jake ward
anl	amgad elgowainy, aymeric rousseau, tom stephens, michael wang, joann zhou
energetics	alicia birky, salil deshpande
ornl	stacy davis, zhenhong lin, changzheng liu
nrel	aaron brooker, mark singer
snl	becky levinson, dawn manley
ta engineering	jim moore, charles taylor
sra/sentech	russ campbell, jonathan ford, karen sikes

29 june 2015

topics

1 energy markets

automotive markets

technologies studies

environmental studies

consumer & opinion surveys

policy studies

qar

outline

1 energy markets

oil markets

> EIA: Oil and gas prices are still at 10-year lows.
> Oil and gas prices have rebounded (~33%) since ~$45/bbl-low in January (but still at 10-year low).

global supply and demand outlooks

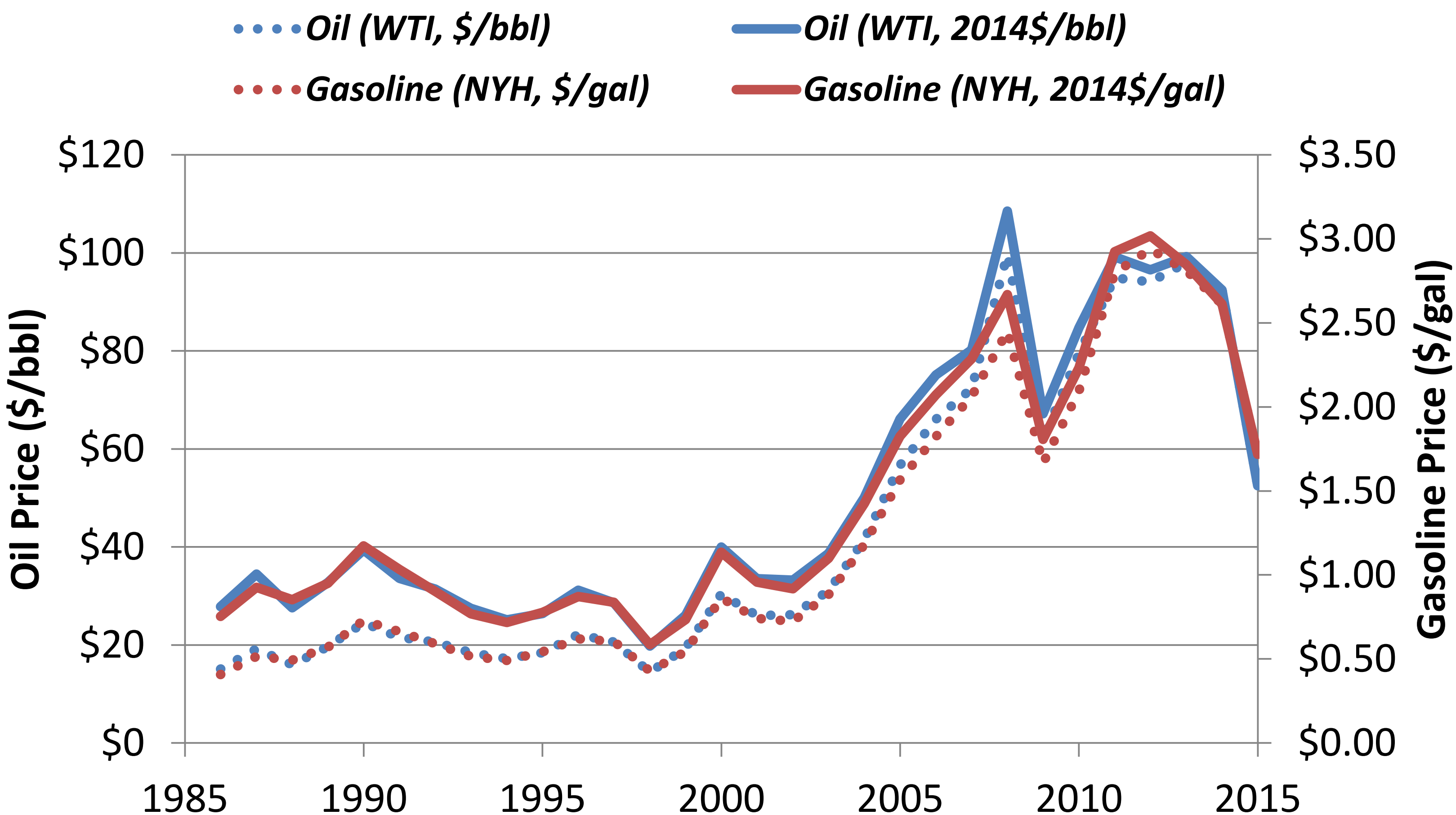
> EIA/BP/ExxonMobil/IEA: Global energy outlooks mostly aligned.
> EIA/BP/ExxonMobil/IEA: Global transportation energy demand increases; U.S. stays level.
> EIA/BP/IEA: World oil production increases, despite U.S. production leveling off.
> EIA/BP/ExxonMobil/IEA: World oil production and transportation energy demand increases keep pace.

alternative fuels

> EIA: Non-petroleum share of transportation energy at highest level since 1954.

oil markets

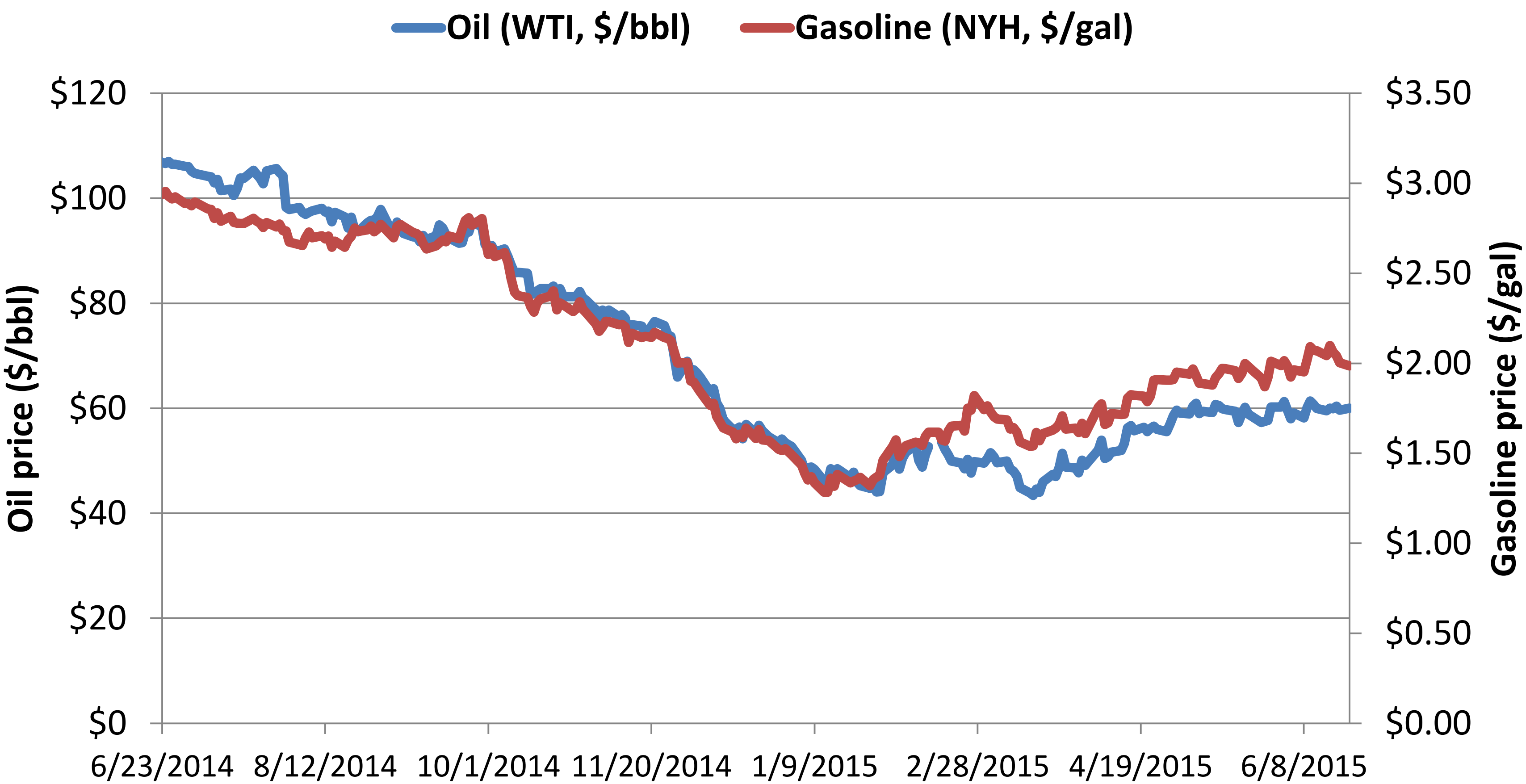
EIA: Oil and gas prices are still at 10-year lows



Source: EIA, http://www.eia.gov/petroleum/data.cfm

oil markets

EIA: Oil and gas prices have rebounded (~33%) since ~$45/bbl-low in January (but *still* at 10-year low).

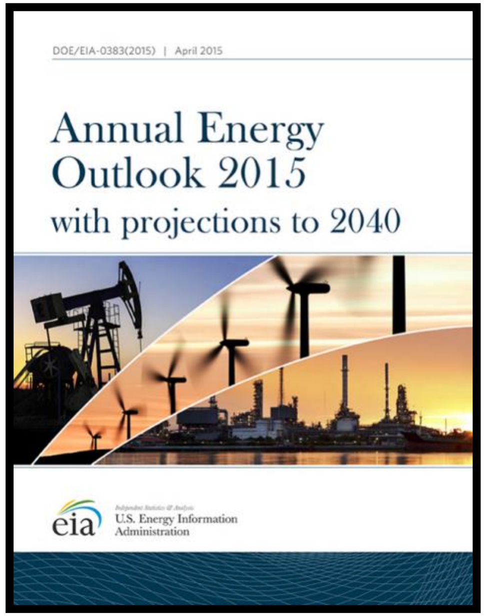


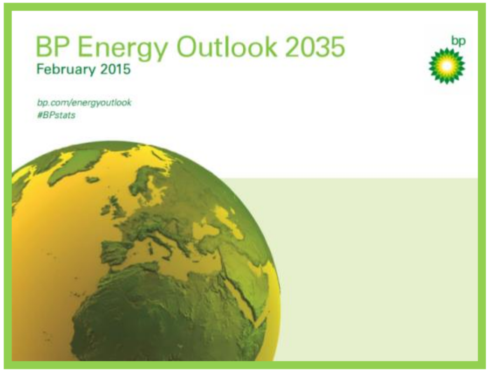
Source: EIA, http://www.eia.gov/petroleum/data.cfm

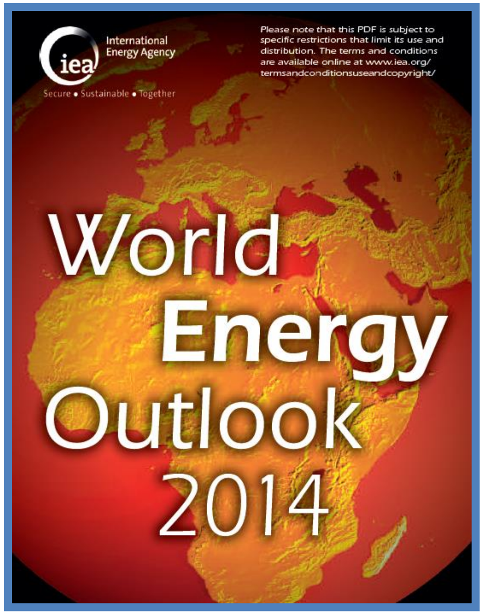
global supply and demand

> EIA/BP/ExxonMobil/IEA: Global energy outlooks mostly aligned.

- **EIA Annual Energy Outlook** (April, 2015)
- **EIA's International Energy** Outlook (November, 2014)
- **BP Energy Outlook 2035** (February, 2015)
- **ExxonMobil's Outlook for Energy 2015** (December, 2014)
- **IEA's World Energy Outlook** (November, 2014)

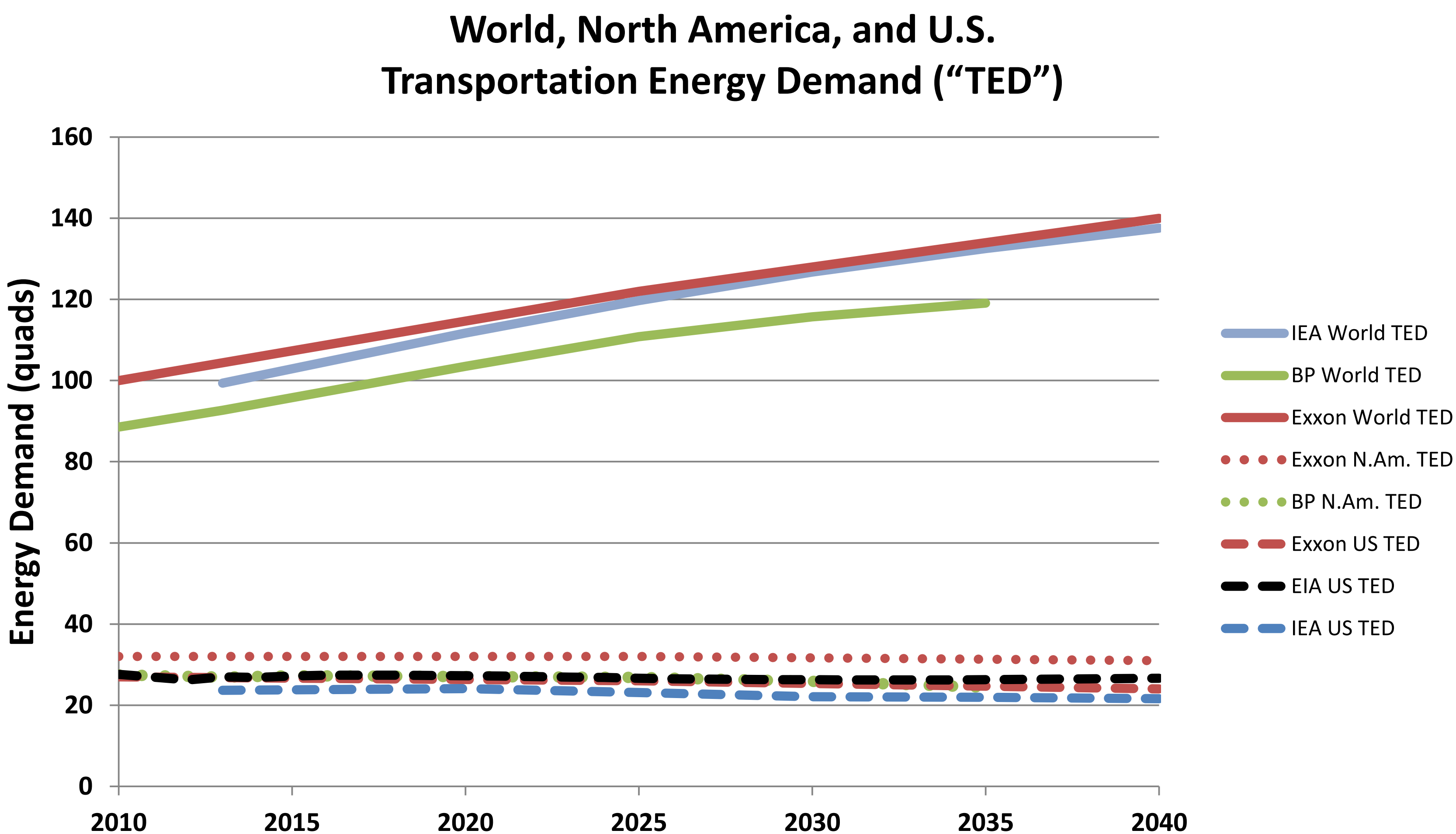






Source: BP, EIA, ExxonMobil

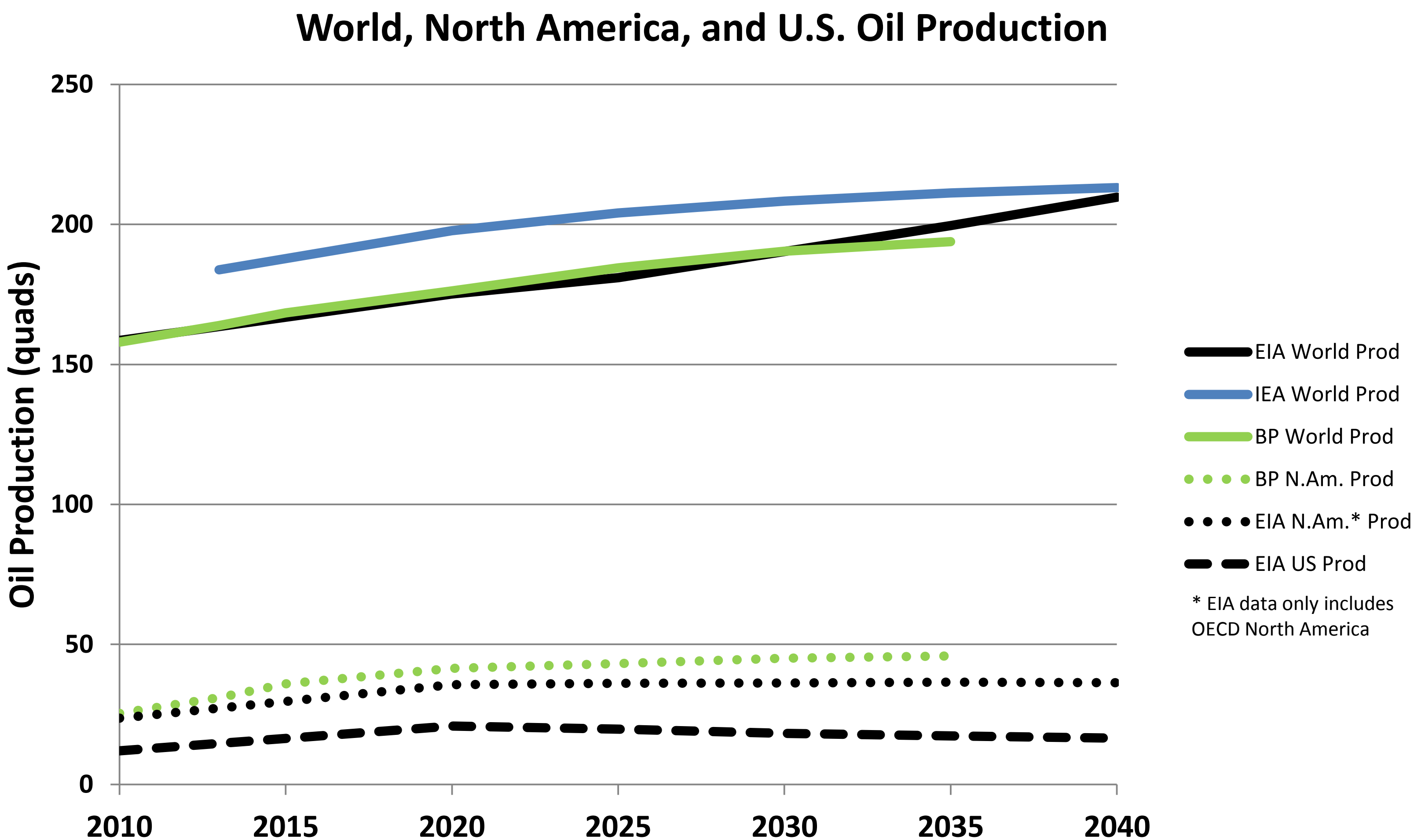
EIA/BP/ExxonMobil/IEA: Global transportation energy demand increases, despite U.S. staying level.



Source: BP, EIA, ExxonMobil, IEA

global supply and demand

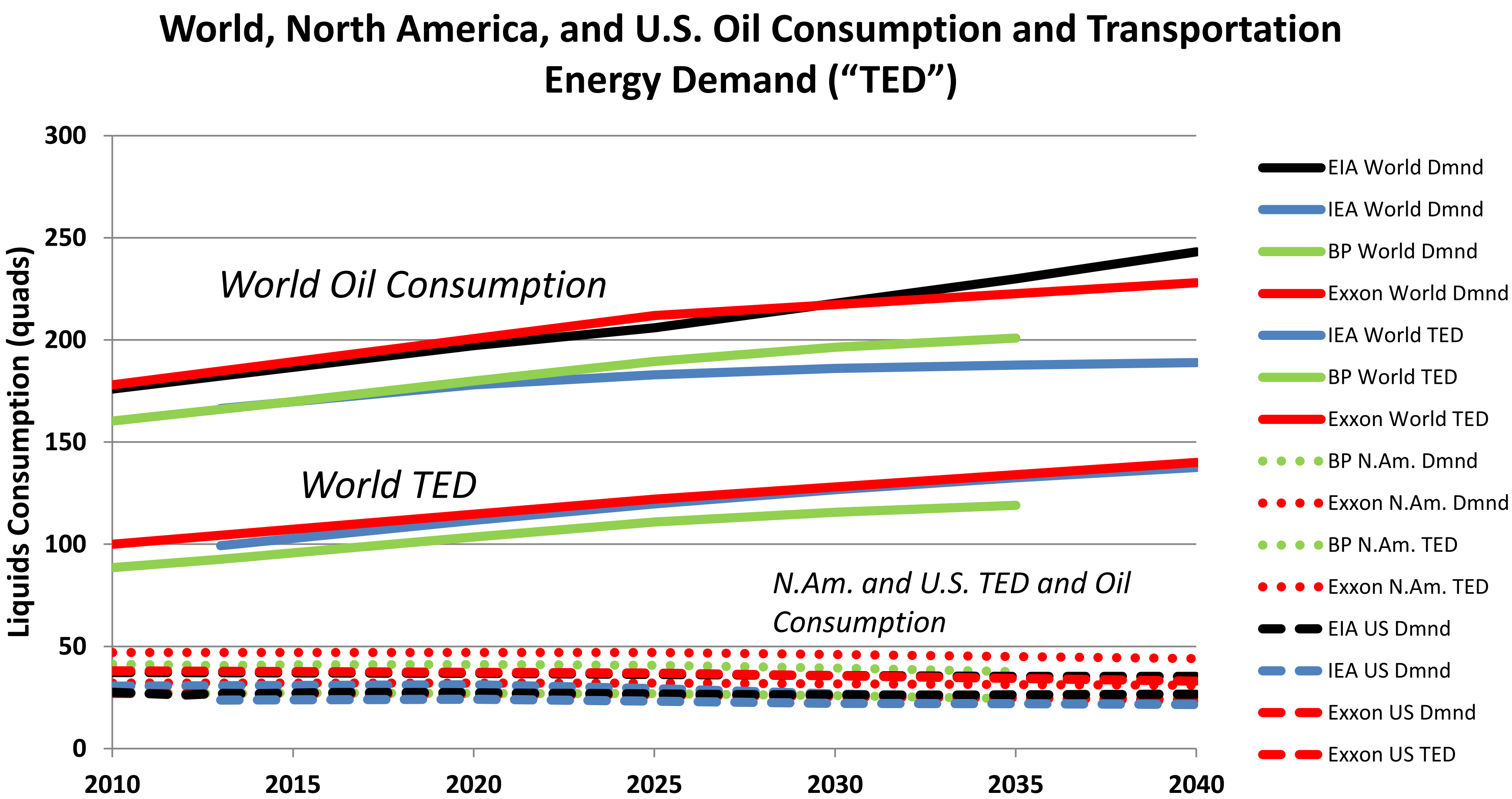
EIA/BP/IEA: World oil production increases, despite U.S. production leveling off.



Source: BP, EIA, ExxonMobil, IEA

petroleum markets

EIA/BP/ExxonMobil/IEA: World oil production and transportation energy demand increases keep pace.

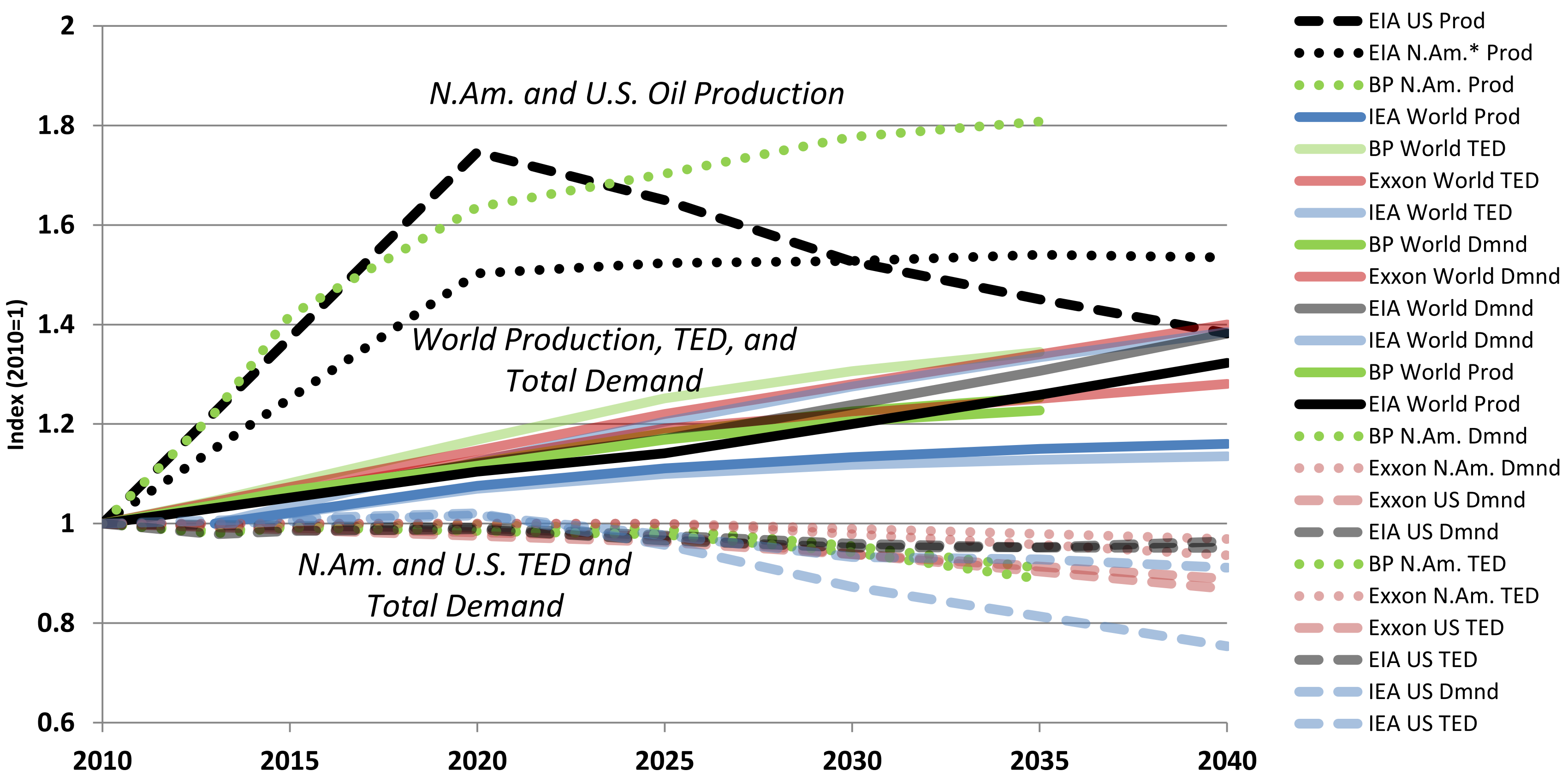


Source: BP, EIA, ExxonMobil, IEA

global supply and demand

EIA/BP/ExxonMobil/IEA: Global energy outlooks mostly aligned.

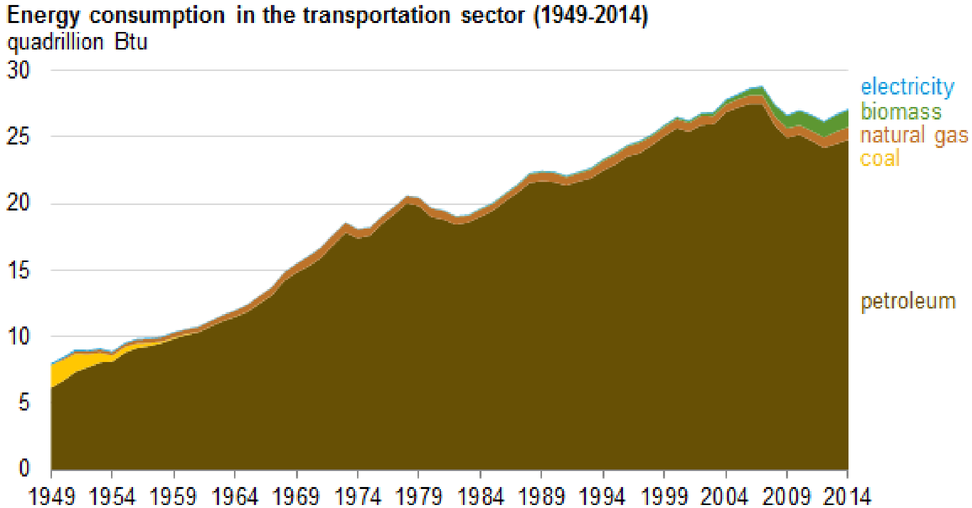
World, North America, U.S. Oil Consumption and Production Outlook (Indexed to 2010)

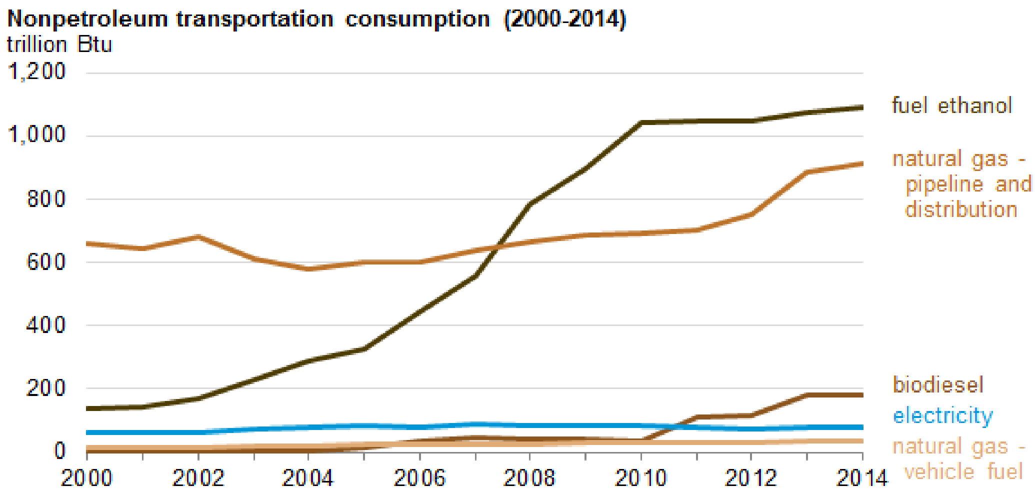


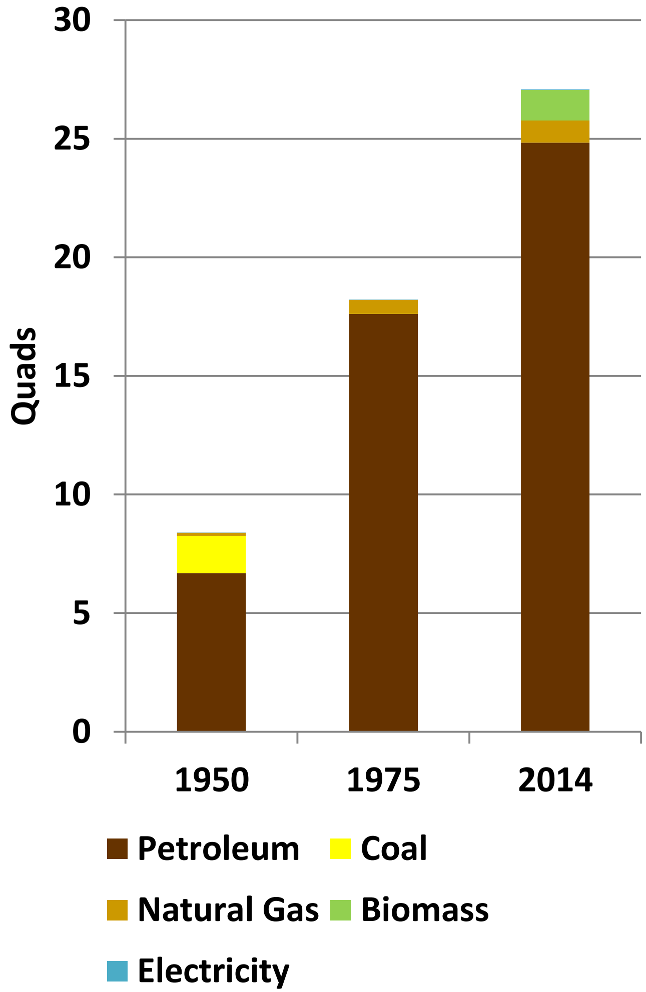
Source: BP, EIA, ExxonMobil, IEA

alternative fuels

EIA: Non-petroleum share of transportation energy at highest level since 1954.







Source: http://www.eia.gov/todayinenergy/detail.cfm?id=21272

topics

energy markets

2 automotive markets

technologies studies

environmental studies

consumers/opinion surveys

policy studies

qar

outline

2 automotive markets

vehicle sales

> FOTW: U.S. 2014 PEV sales highest in the world, and among highest per capita.
> FOTW: PEV sales total nearly 120,000 units in 2014; nearly 300,000 cumulatively.

vehicle trends

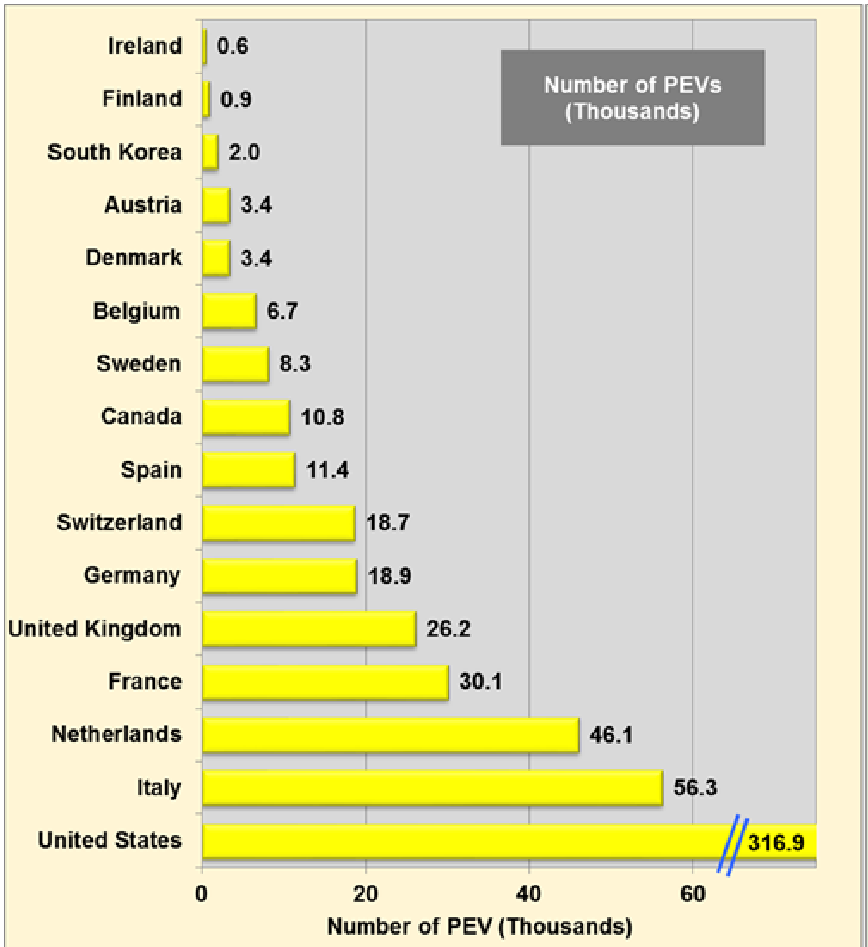
> ANL: Range-extension technologies increasingly attractive away from city center.
> ANL: PEV sales per capita increase as population density declines (and moreso for PHEVs than BEVs).
> FOTW: PEV penetration varies (sometimes greatly) by state.
> FOTW: BEV-to-PHEV ratios differ (sometimes greatly) by state.
> FOTW: HEV sales also vary by state, and is somewhat correlated with state PEV sales.
> Navigant: Start-stop and alt-fuel vehicles comprise over 70% and 13%, respectively, of global LDV sales in 2035
> Navigant: Global share of conventional ICE vehicles falls to under 40% by 2035.
> Navigant: North American market shrinks from over 20% of global LDV sales in 2015 to over 15% in 2035.

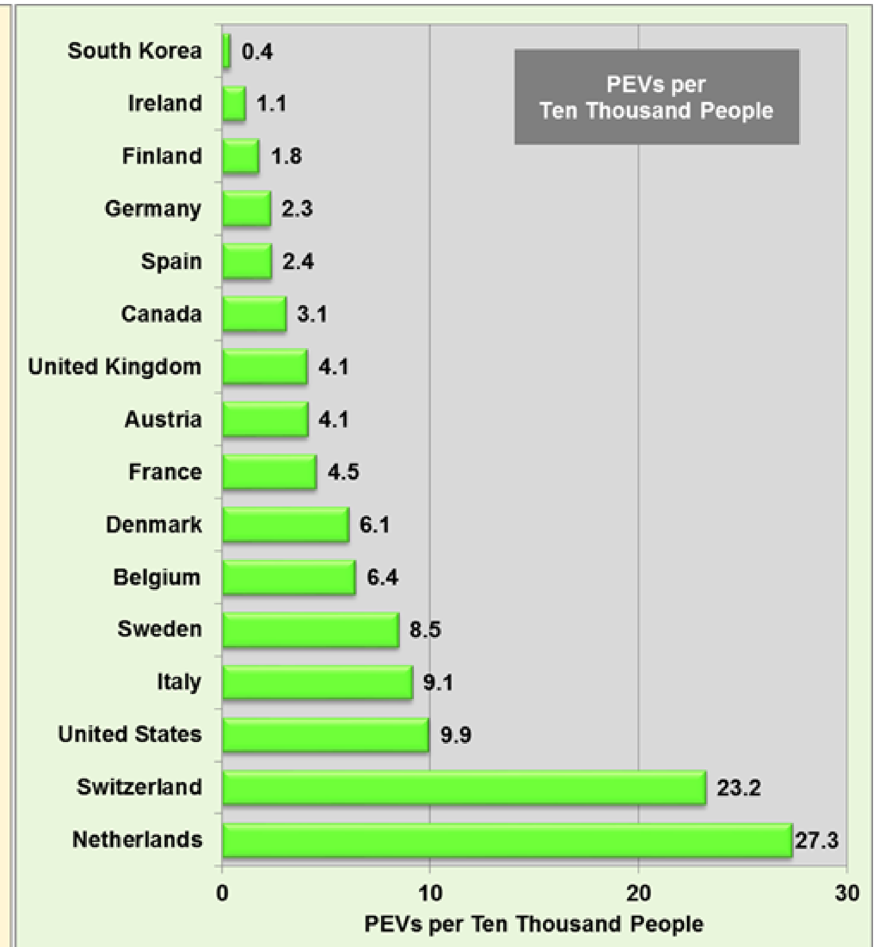
PEV depreciation

> NADA: National Automobile Dealers’ Association publishes 3-year depreciation rates for PEVs.
> ANL: BEVs may depreciate comparably to ICEVs, pending further study (e.g., incentives?).
> ANL: PHEVs may depreciate more than ICEVs, pending further study (e.g., incentives?).

vehicle sales

FOTW: U.S. 2014 PEV sales highest in the world, and among highest per capita.

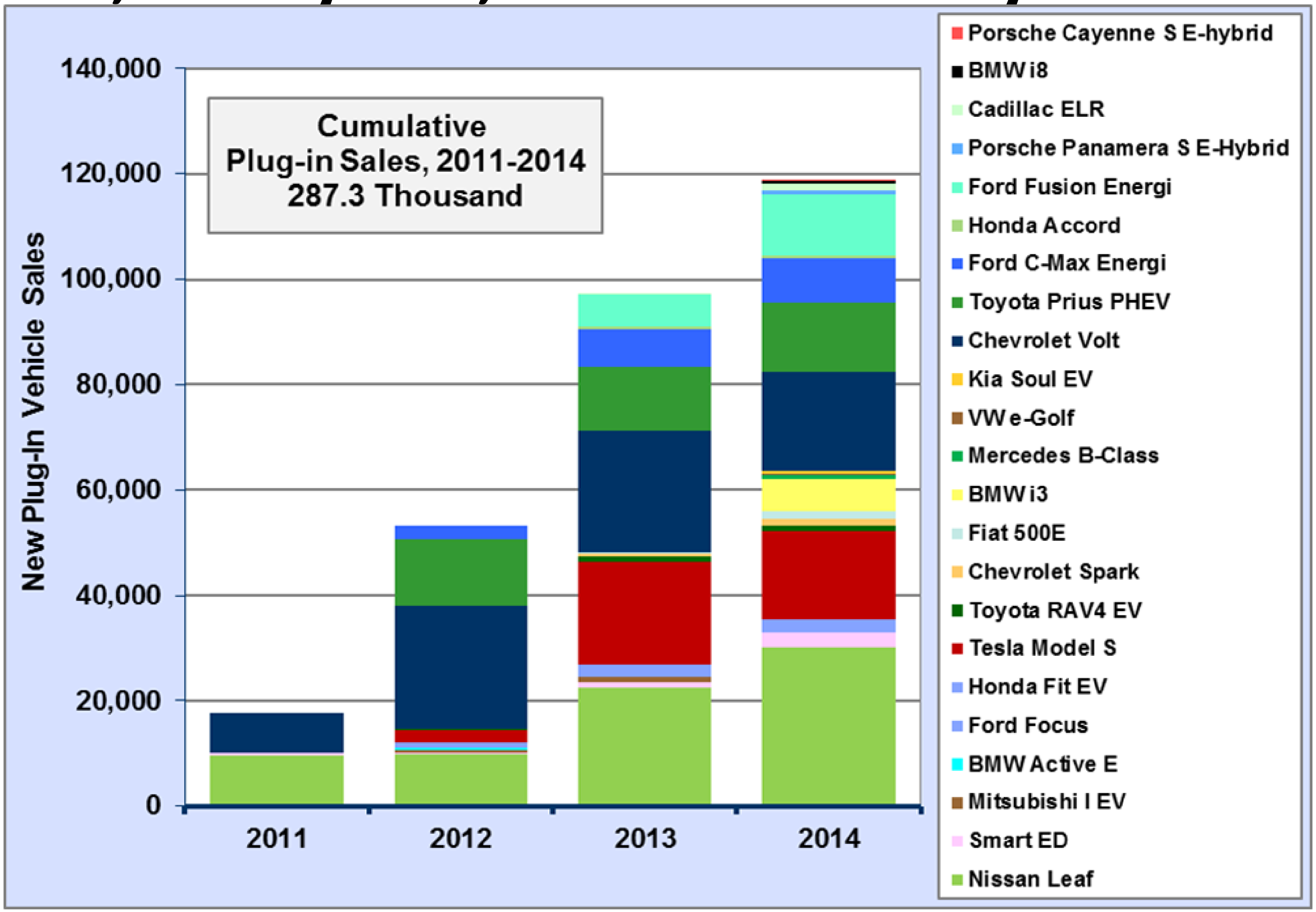




Source: http://energy.gov/eere/vehicles/fact-878-june-22-2015-plug-vehicle-penetration-selected-countries-2014

vehicle sales

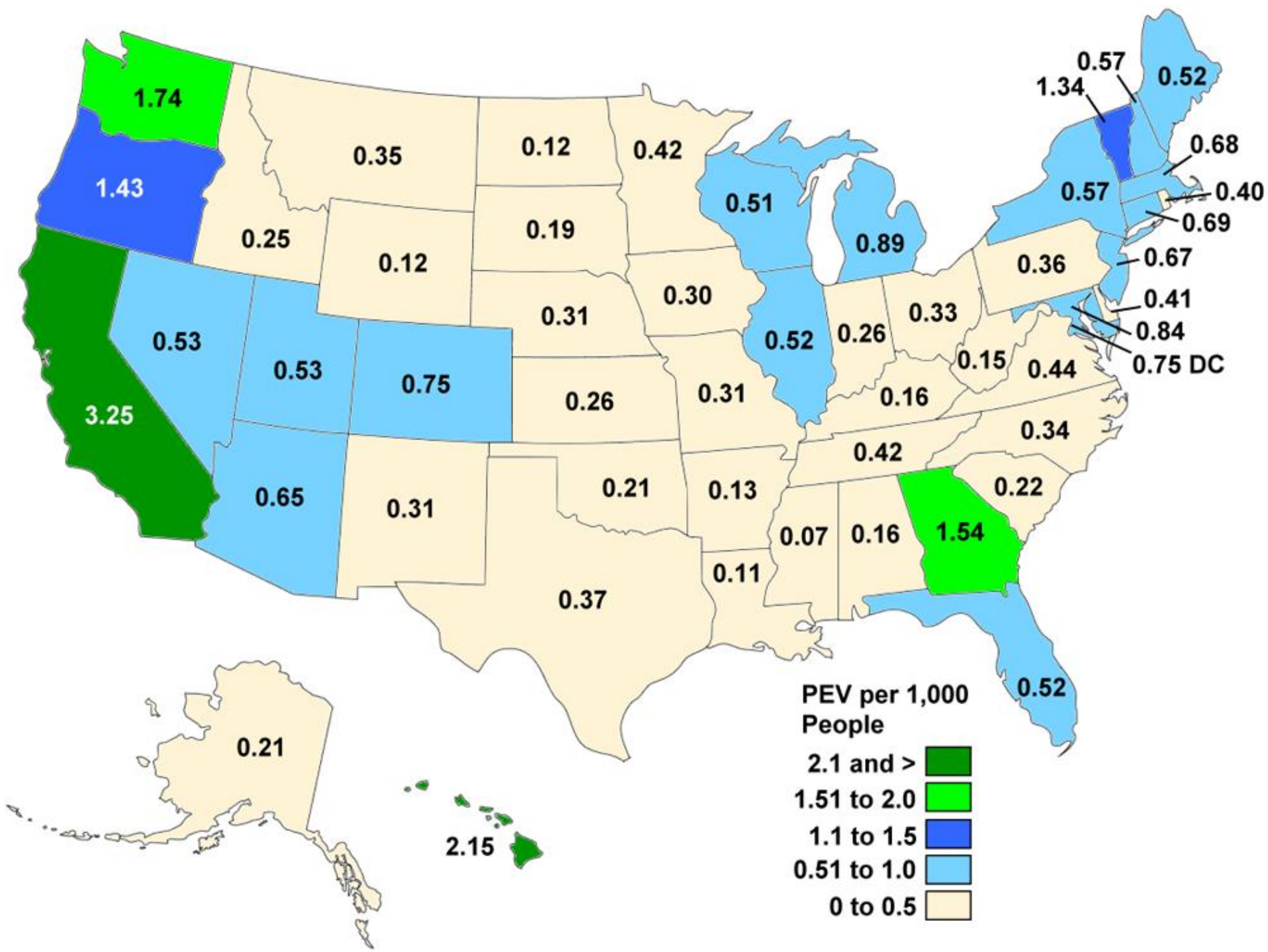
FOTW: PEV sales total nearly 120,000 units in 2014; nearly 300,000 cumulatively.



Source: http://energy.gov/eere/vehicles/fact-873-may-18-2015-plug-vehicle-sales-total-nearly-120000-units-2014

ev incentives

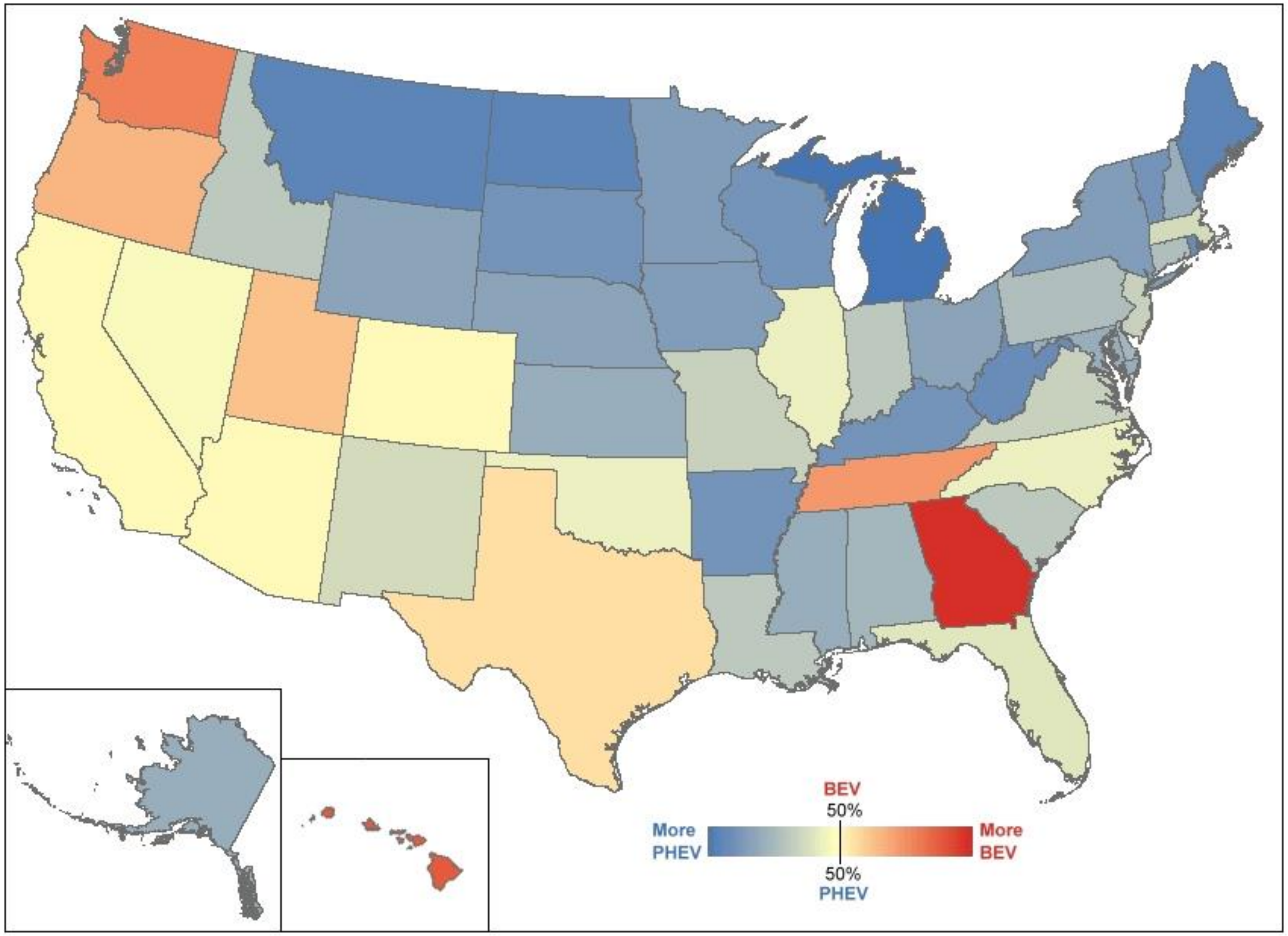
FOTW: PEV penetration varies (sometimes greatly) by state.



Source: http://energy.gov/eere/vehicles/fact-876-june-8-2015-plug-electric-vehicle-penetration-state-2014

ev incentives

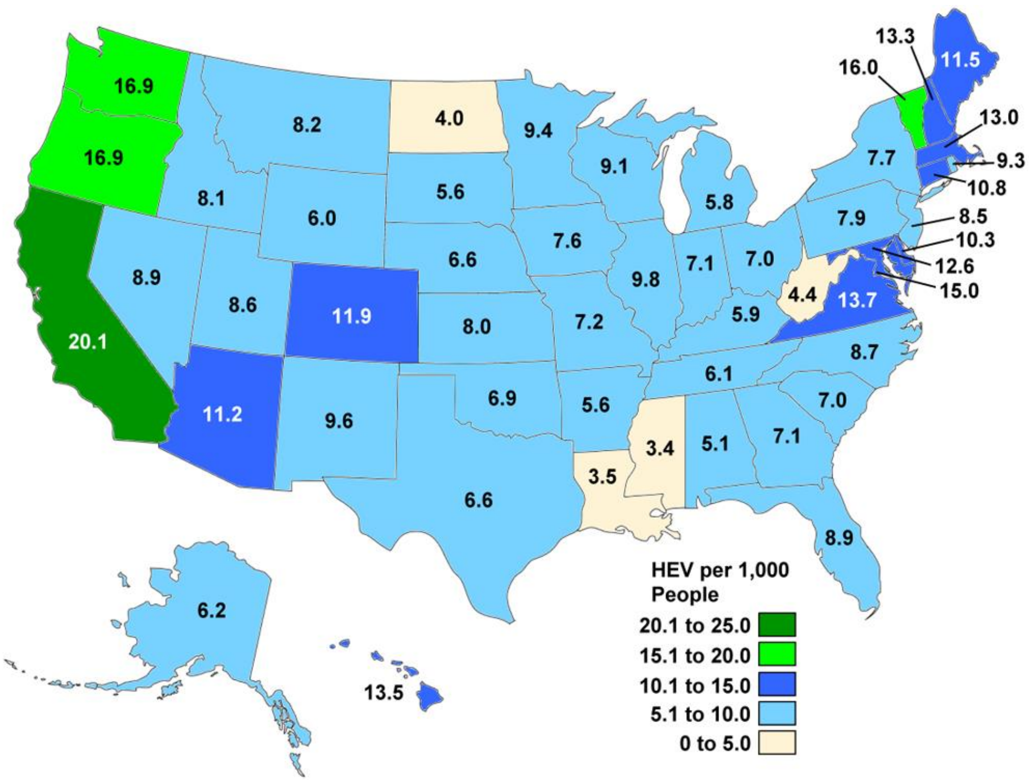
FOTW: BEV-to-PHEV ratios differ (sometimes greatly) by state.

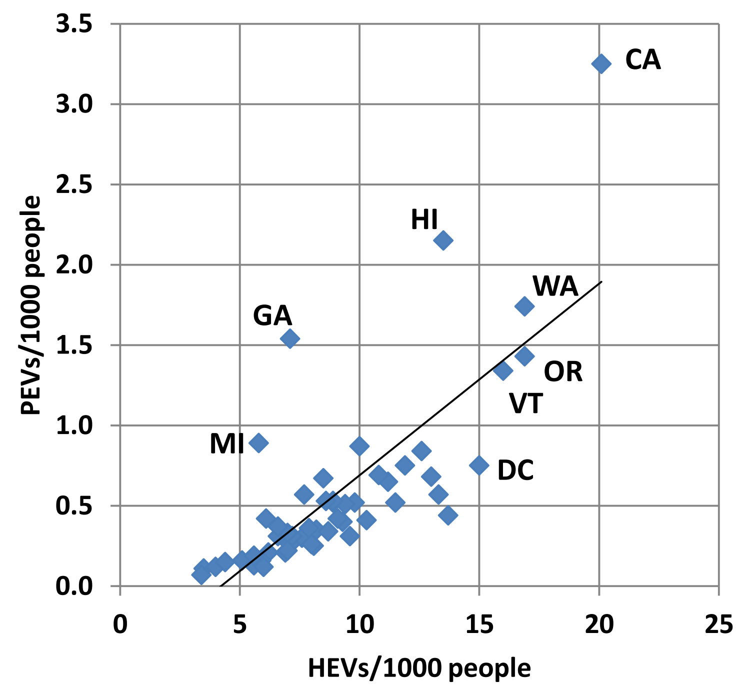


Source: http://energy.gov/eere/vehicles/fact-877-june-15-2015-which-states-have-more-battery-electric-vehicles-plug-hybrids

ev incentives

FOTW: HEV sales also vary by state, and is somewhat correlated with state PEV sales.

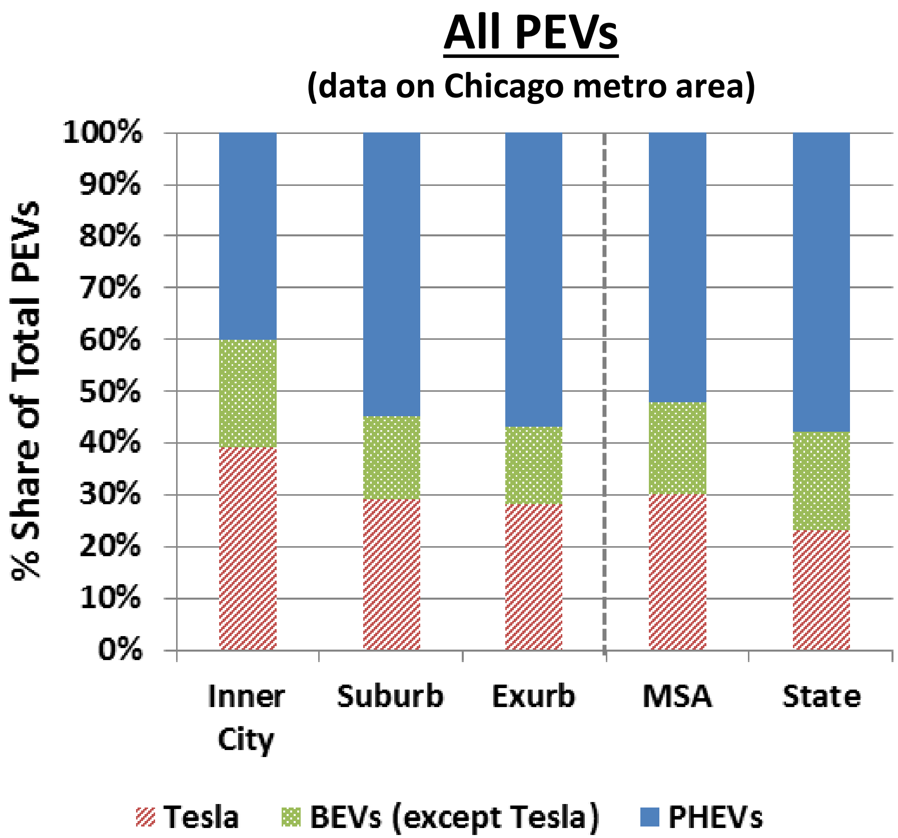


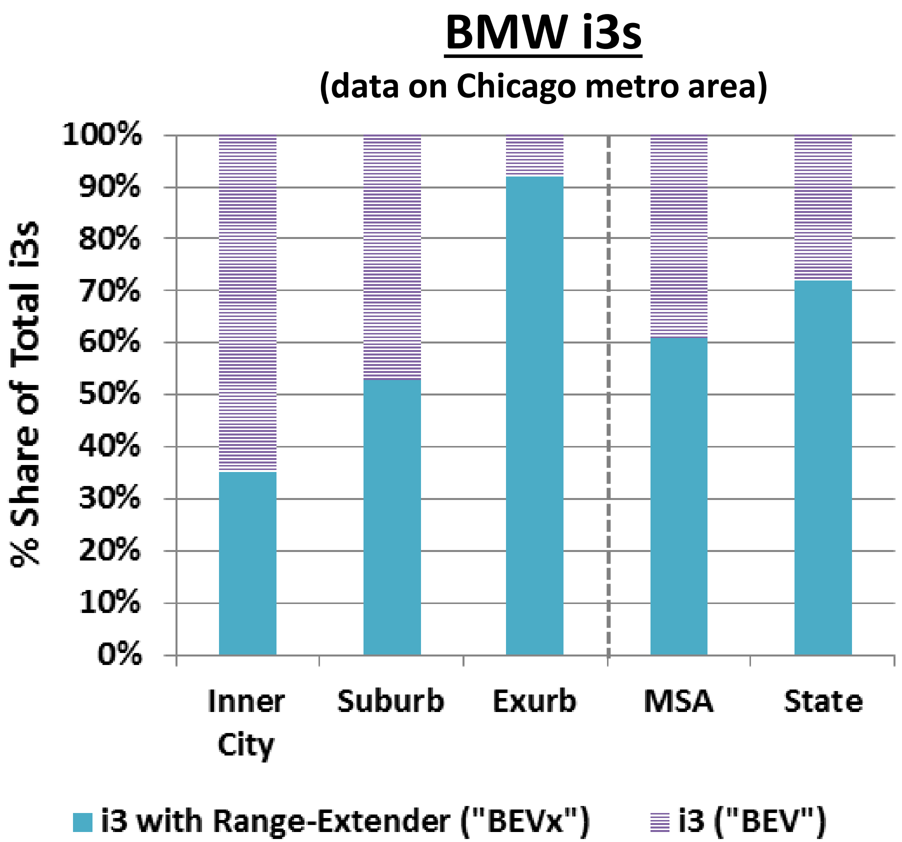


Source: http://energy.gov/eere/vehicles/fact-875-june-1-2015-hybrid-electric-vehicle-penetration-state-2014

vehicle trends

ANL: Range-extension technologies increasingly attractive away from city center.

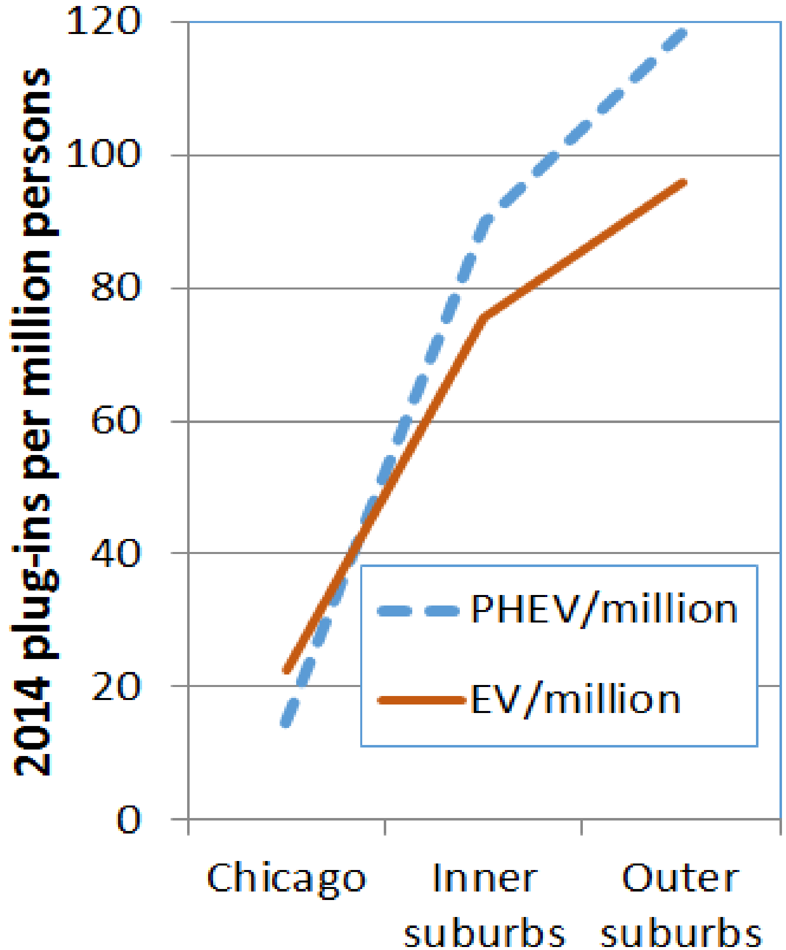




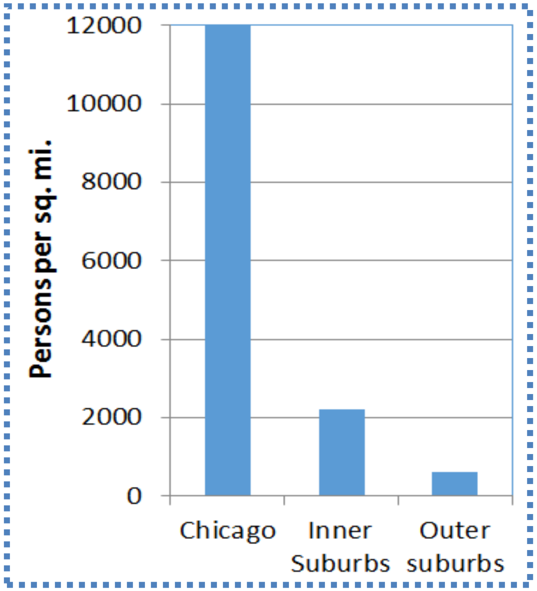
Source: Zhou, Y. ANL (2015); Registration data provided by NREL.

vehicle trends

ANL: PEV sales per capita increase as population density declines (and moreso for PHEVs than BEVs).



Note: population densities considered:

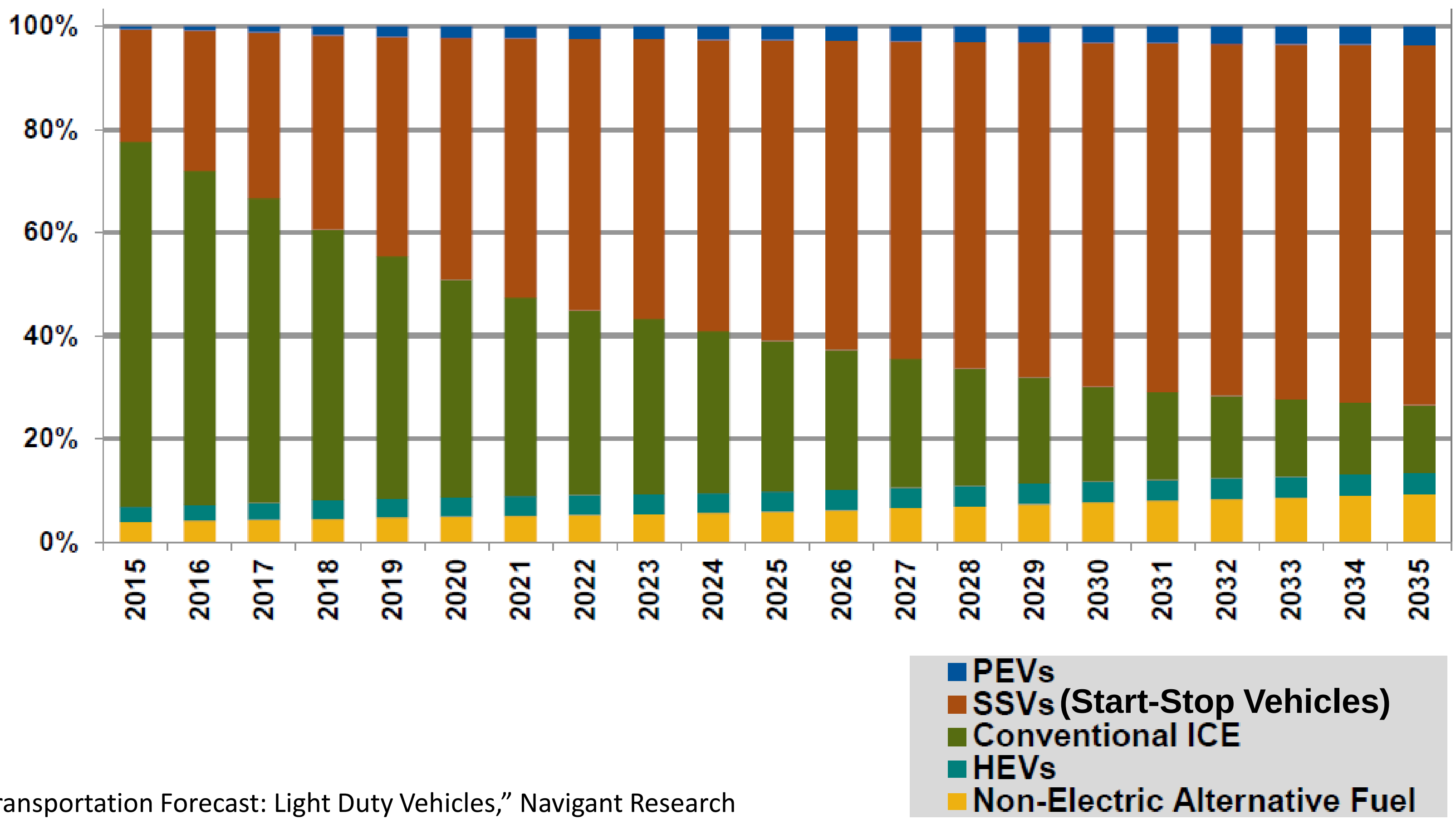


Source: Zhou, Y. ANL (2015).

vehicle trends

Navigant: Start-stop and alt-fuel vehicles comprise over 70% and 13%, respectively, of global LDV sales in 2035.

World LDVs *sales* by drivetrain

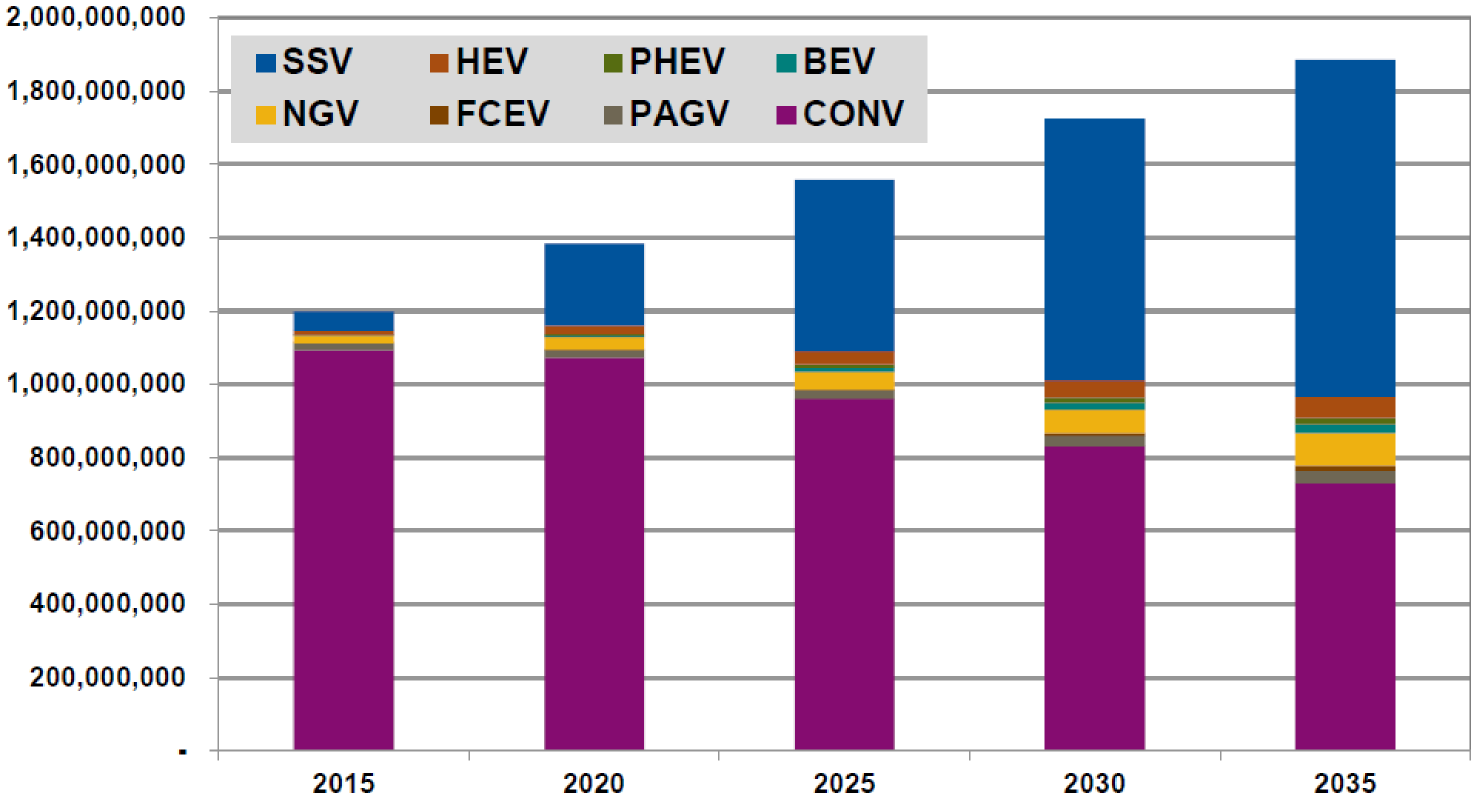


Source: "Transportation Forecast: Light Duty Vehicles," Navigant Research Report, Published 2Q 2015.

vehicle trends

Navigant: Global share of conventional ICE vehicles falls to under 40% by 2035.

<u>World LDVs *in use* (total stock) by drivetrain</u>



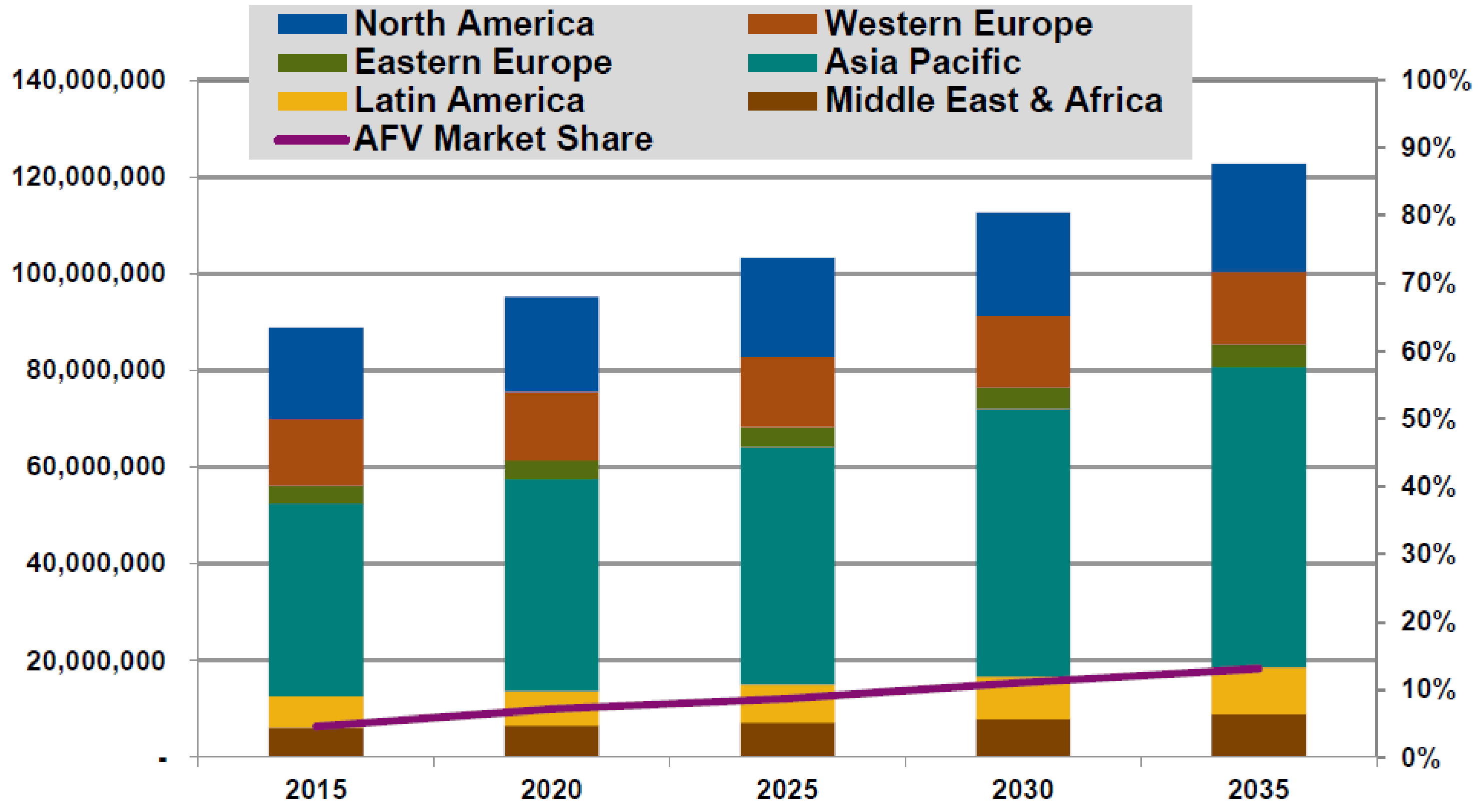
Acronyms: SSV – Start-Stop Vehicle; PAGV – Propane; CONV = Conventional ICEV

Source: "Transportation Forecast: Light Duty Vehicles," Navigant Research Report, Published 2Q 2015.

vehicle trends

Navigant: North American market shrinks from over 20% of global LDV sales in 2015 to over 15% in 2035.

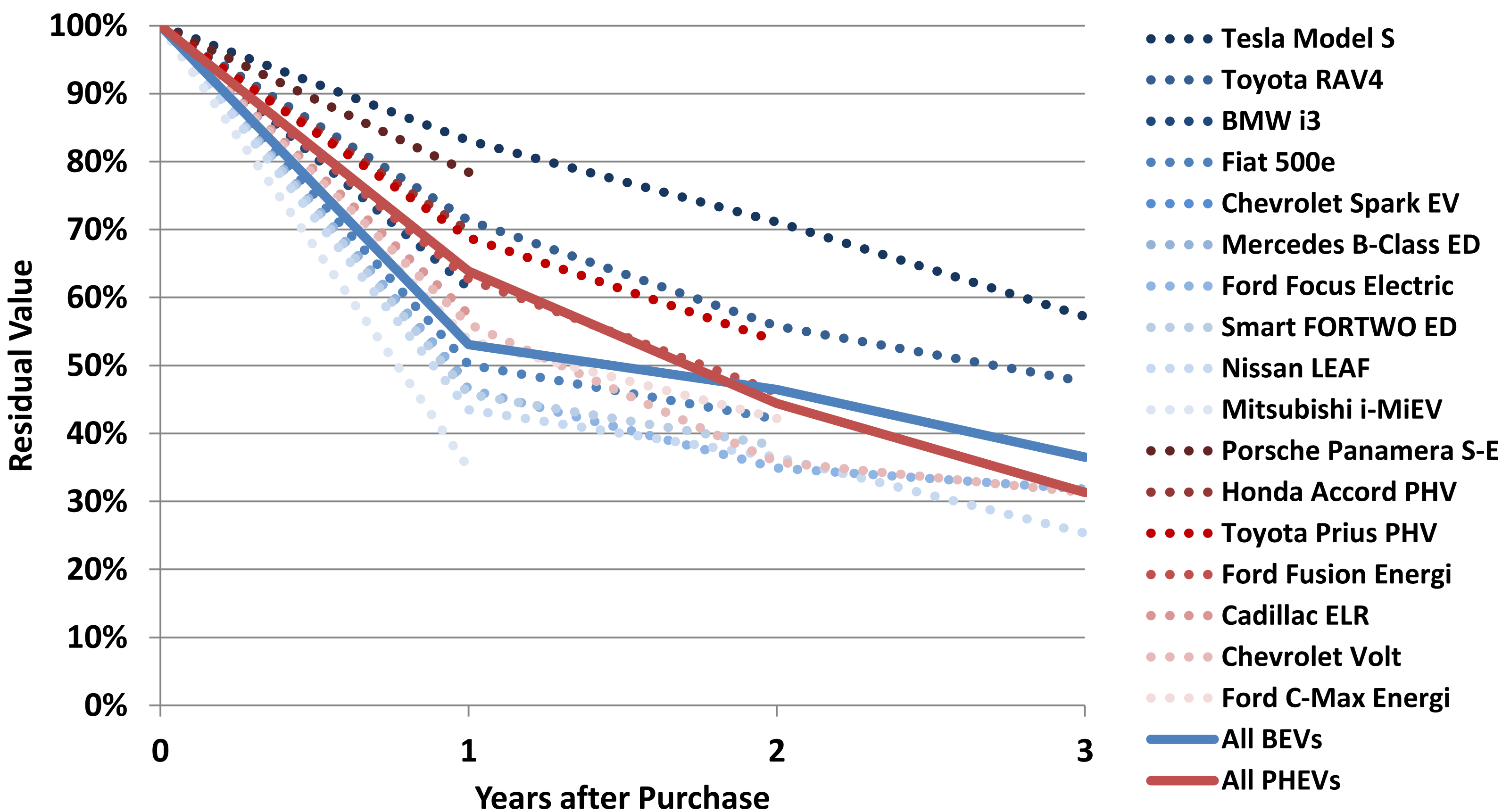
World LDV *sales* by region



Source: "Transportation Forecast: Light Duty Vehicles," Navigant Research Report, Published 2Q 2015.

PEV depreciation

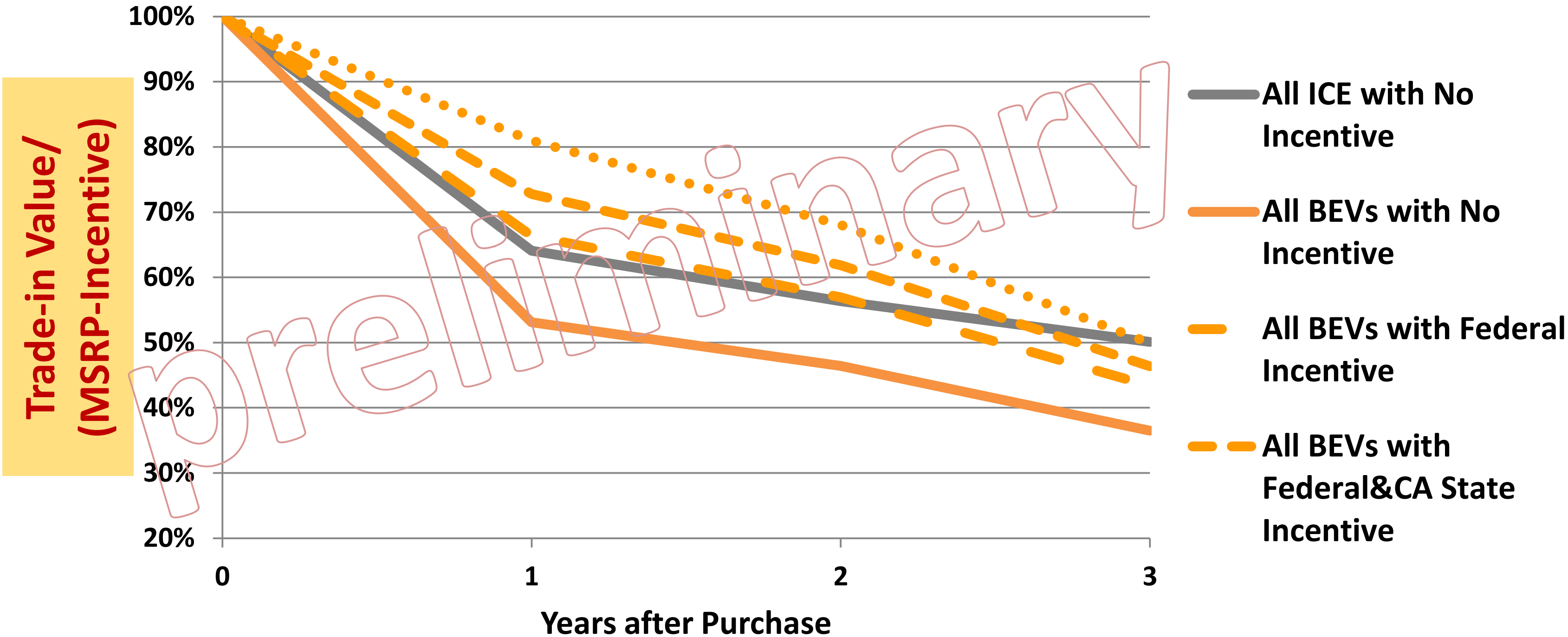
NADA: National Automobile Dealers' Association publishes 3-year depreciation rates for PEVs.



Source: NADA (2015), Source: http://img03.en25.com/Web/NADAUCG/%7B413f55a5-807f-4b2e-8310-48cd4aeb40da%7D_April_2015_NADA_Perspective.pdf

PEV depreciation

ANL: BEVs may depreciate comparably to ICEVs; though, further study (e.g., incentives?) is important.



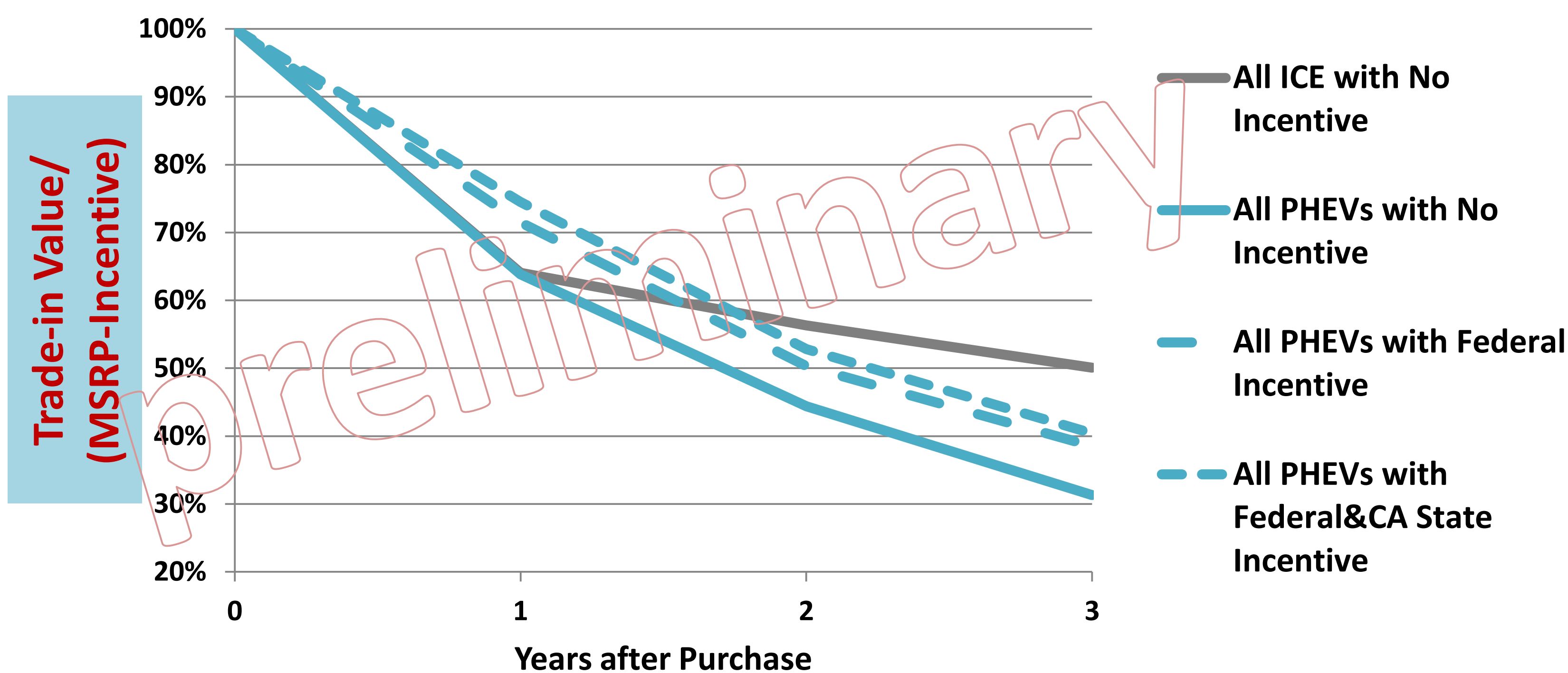
Notes:

- *ICEs include 13 models comparable to selected PEVs, PEV depreciation rates come from recently released NADA report, ICE depreciation rates come from NADA guide; Information is for 2012-2014 models.*
- *Federal incentive is up to $7500 as a function of battery size; CA provides $2500 incentive for BEVs and $1500 for PHEVs*

Source: Zhou, Y. ANL (2015).

PEV depreciation

ANL: PHEVs may depreciate more than ICEVs; though, further study (e.g., incentives?) is important.



Notes:

- *ICEs include 13 models comparable to selected PEVs, PEV depreciation rates come from recently released NADA report, ICE depreciation rates come from NADA guide; Information is for 2012-2014 models.*
- *Federal incentive is up to $7500 as a function of battery size; CA provides $2500 incentive for BEVs and $1500 for PHEVs*

Source: Zhou, Y. ANL (2015).

topics

energy markets

automotive markets

3 technologies studies

environmental studies

consumers/opinion surveys

policy studies

qar

outline

3 technologies studies

vehicle technology

> FOTW: GDI captures 38% market share in just 7 years from first significant use.

> FOTW: Technology advances facilitate co-improvement of power, acceleration, and, recently, fuel economy.

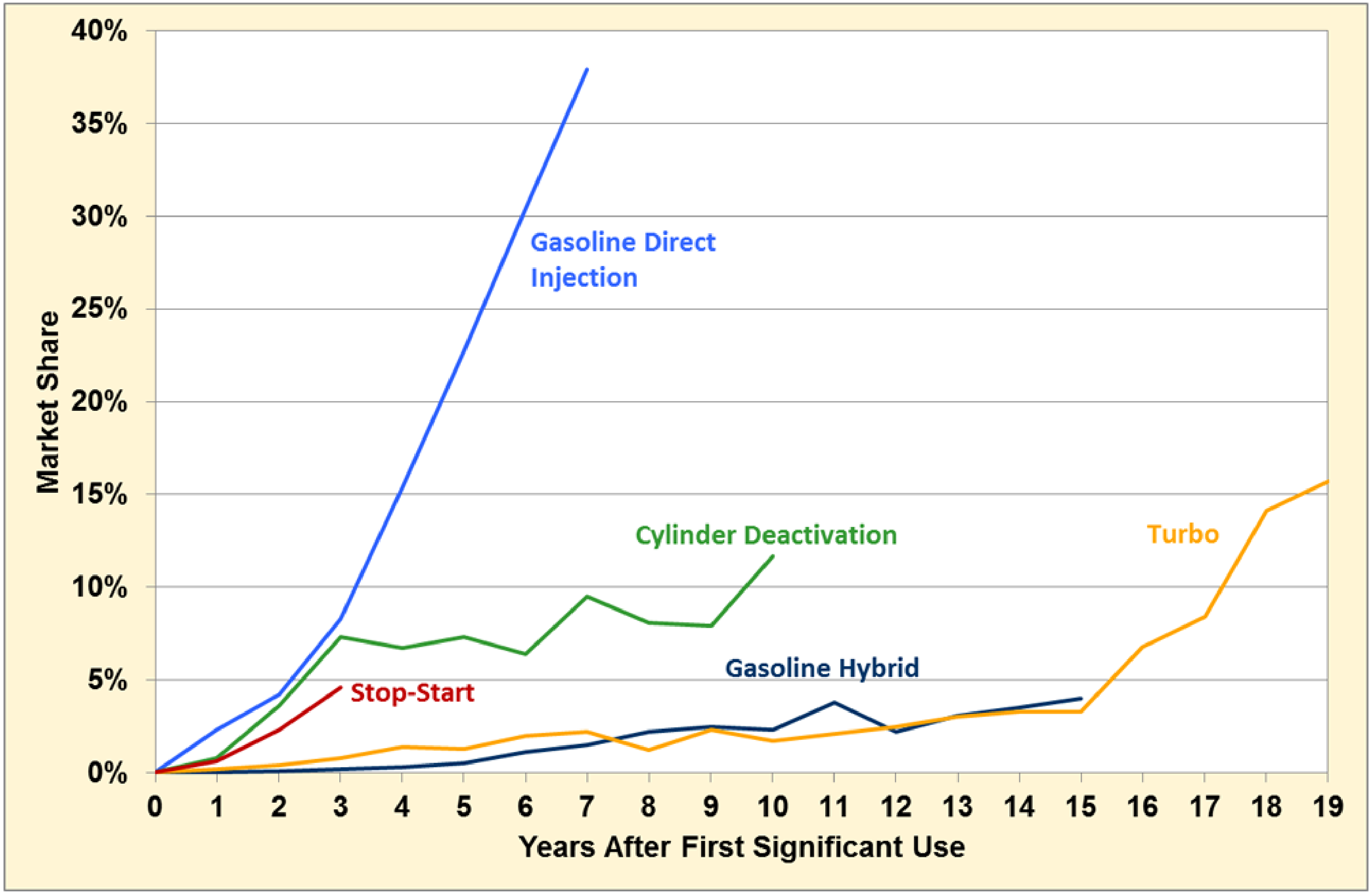
> ANL: Potential alt-fuel vehicle fuel savings1 differ by technology and average speed

ev infrastructure

> FOTW: Number of [public] EV charging outlets continues to increase

vehicle technology

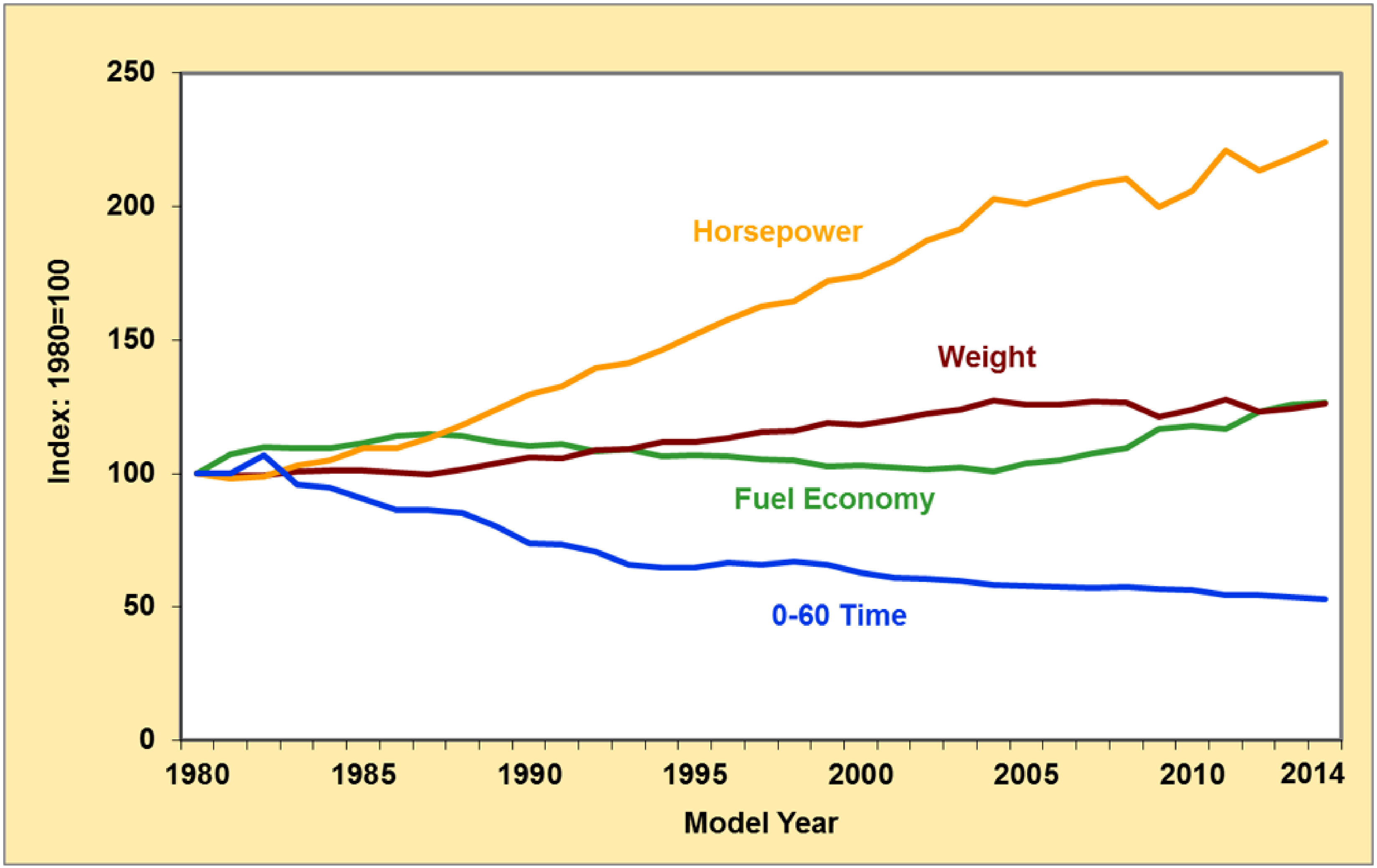
FOTW: GDI captures 38% market share in just 7 years from first significant use.



Source: http://energy.gov/eere/vehicles/fact-869-april-20-2015-gasoline-direct-injection-captures-38-market-share-just-seven

vehicle technology

FOTW: Technology advances facilitate co-improvement of power, acceleration, and, recently, fuel economy.

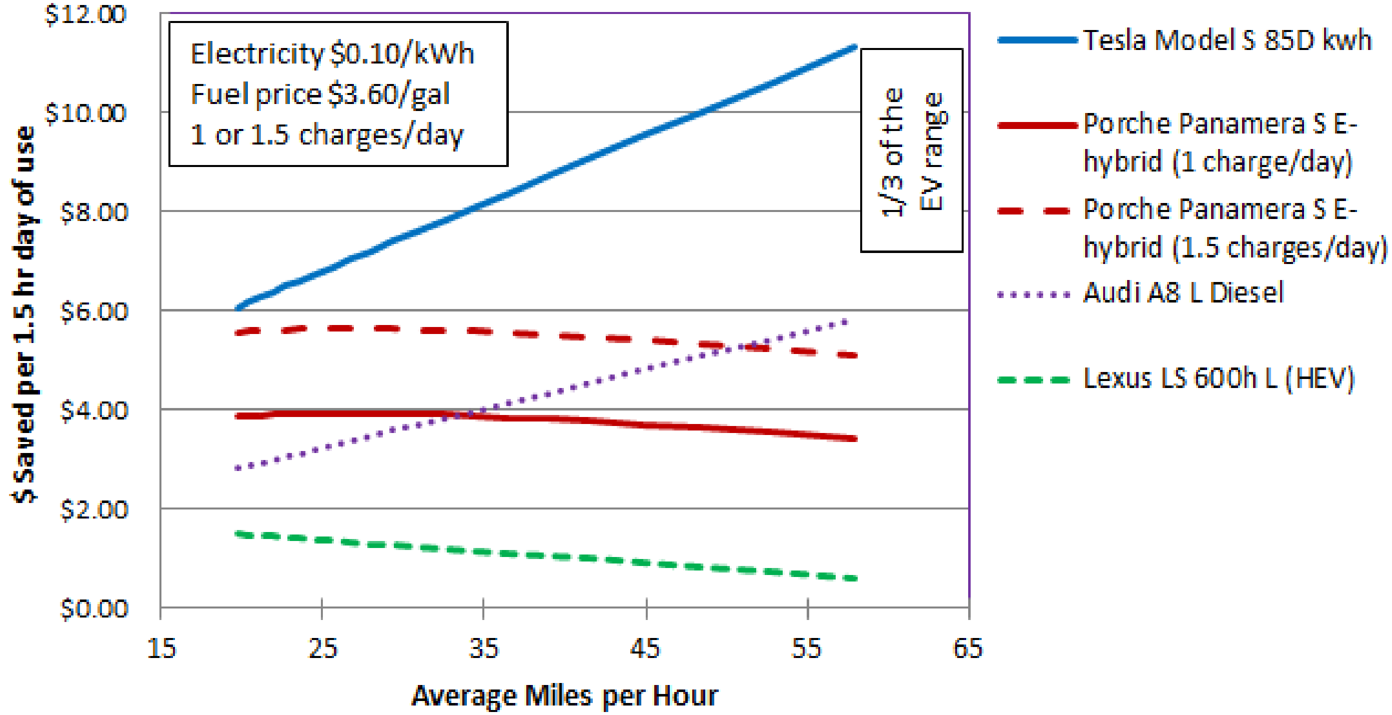


Source: http://energy.gov/eere/vehicles/fact-868-april-13-2015-automotive-technology-has-improved-performance-and-fuel-economy

vehicle technology

ANL: Potential alt-fuel vehicle fuel savings[1] differ by technology and average speed

High performance BEVs save much more than PHEVs



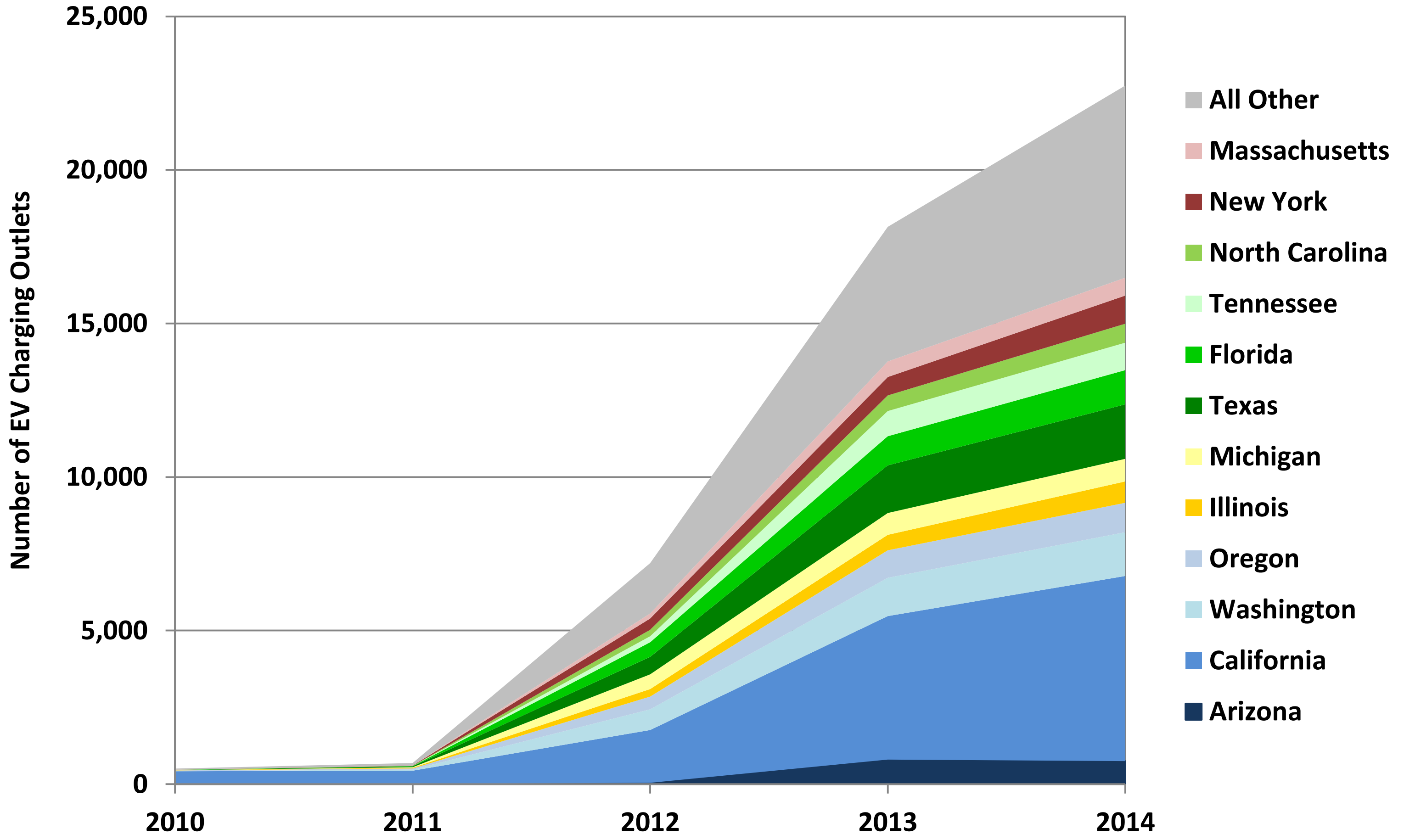
Notes:

- ***[1]Potential fuel savings measured vs. conventional counterpart***
- *Above estimates assumed 1.5 hours/day of use and 1 charge/day*
- *MY2014 fuel efficiencies from fueleconomy.gov*

Source: Zhou, Y. ANL (2015).

ev infrastructure

FOTW: Number of [public] EV charging outlets continues to increase



Source: Davis, S. ORNL (2015); AFDC

topics

energy markets

automotive markets

technologies studies

4 environmental studies

consumers/opinion surveys

policy studies

qar

outline

4environmental studies

emissions

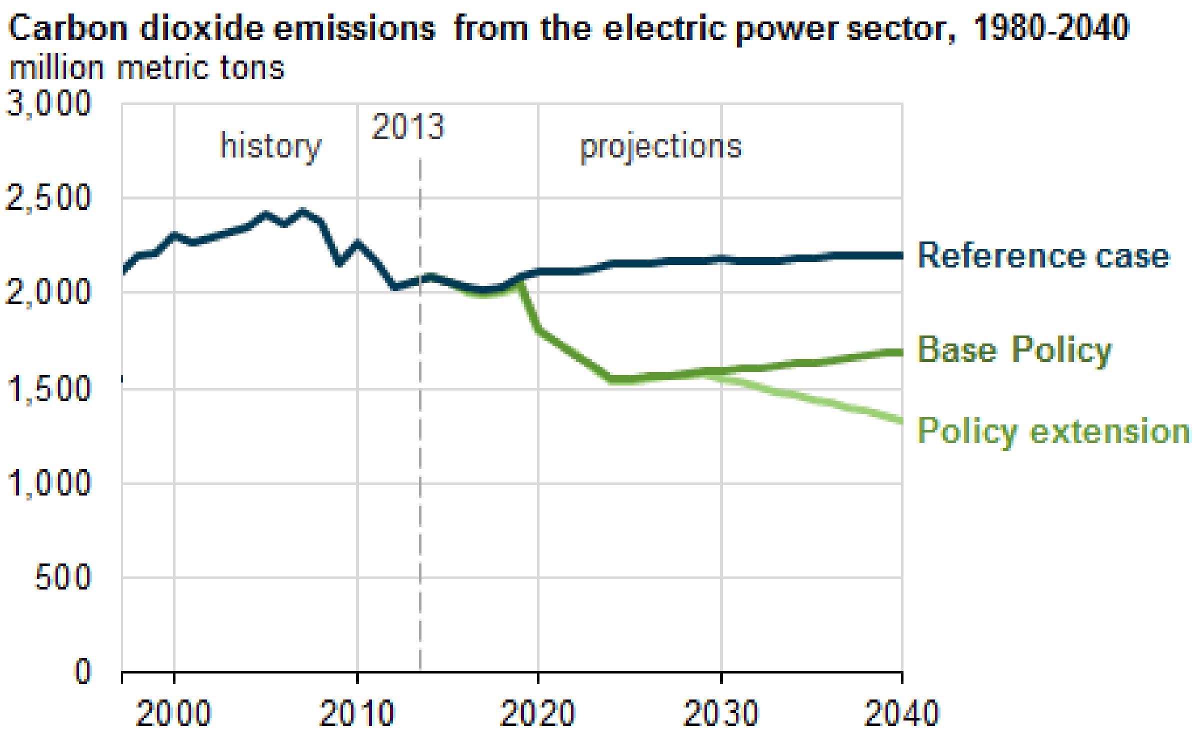
> EIA: EPA's Proposed Clean Power Plan rule cuts power sector CO2 emissions to lowest level since 1980s.

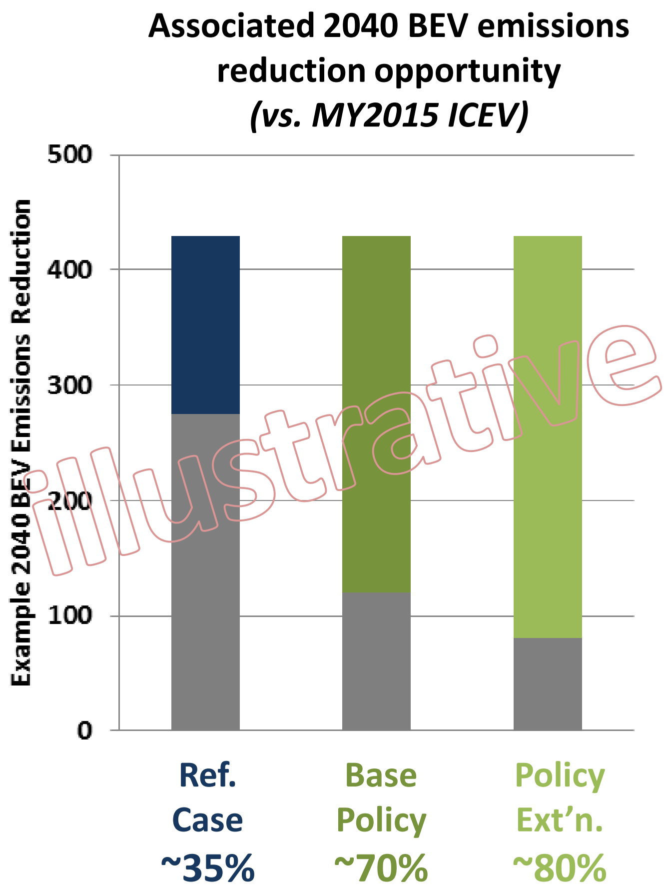
> EIA: Under the proposed Clean Power Plan, natural gas, then renewables, gain generation share.

> ANL: GREET report concludes oil-sand emissions higher than those from conventional sources.

emissions studies

EIA: EPA's Proposed Clean Power Plan rule cuts power sector CO_2 emissions to lowest level since 1980s.

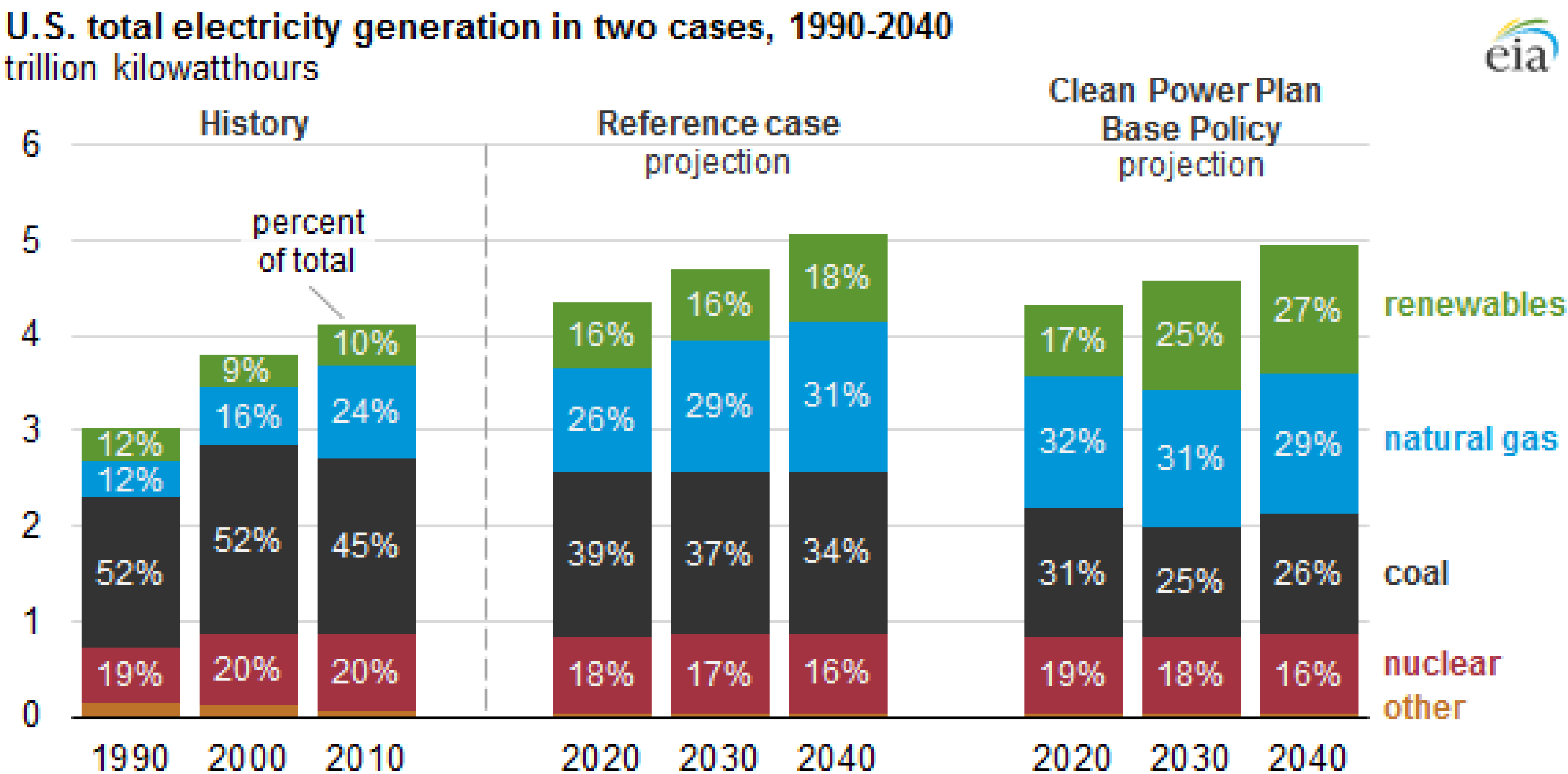




Source: http://www.eia.gov/todayinenergy/detail.cfm?id=21372

emissions studies

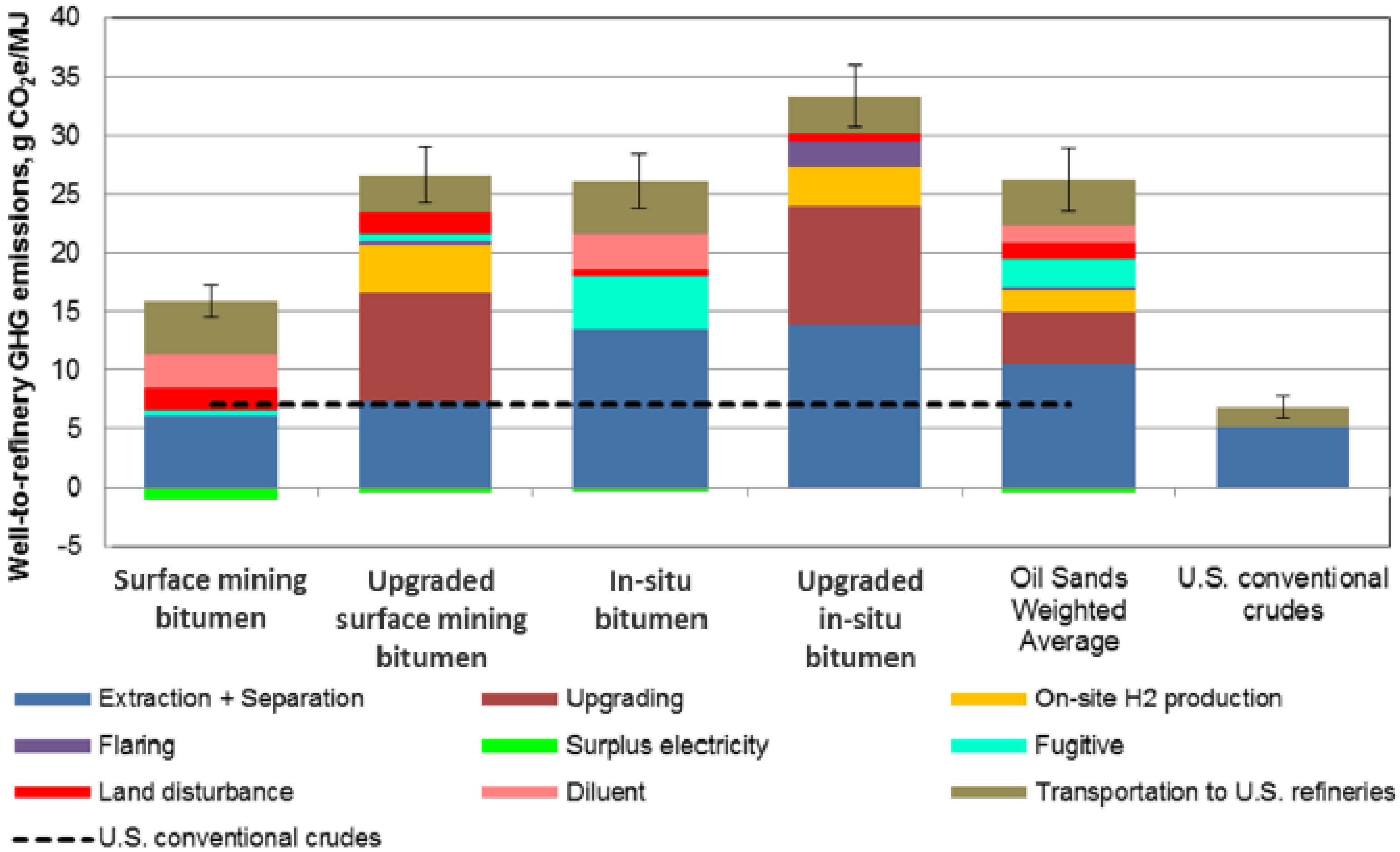
EIA: Under the proposed Clean Power Plan, natural gas, then renewables, gain generation share.



Source: http://www.eia.gov/todayinenergy/detail.cfm?id=21392

emissions studies

ANL: GREET report concludes oil-sand emissions are higher than those from conventional sources.



Source: Wang, M. ANL (2015).

topics

energy markets
automotive markets
technologies studies
environmental studies
5 consumers/opinion surveys
policy studies

qar
outline

5 consumer & opinion surveys

consumer preferences

> NREL: Public opinion is split on PEV attractiveness, and the majority are unlikely to even consider a PEV.

> NREL: Most consumers cannot name a PEV model; though, most indicate at least indirect PEV experience.

> NREL: Most consumers can plug in at home; though, very few are aware of away-from-home charging.

> NREL: The median preferred range for consumers to consider purchasing a BEV is 250-300 miles.

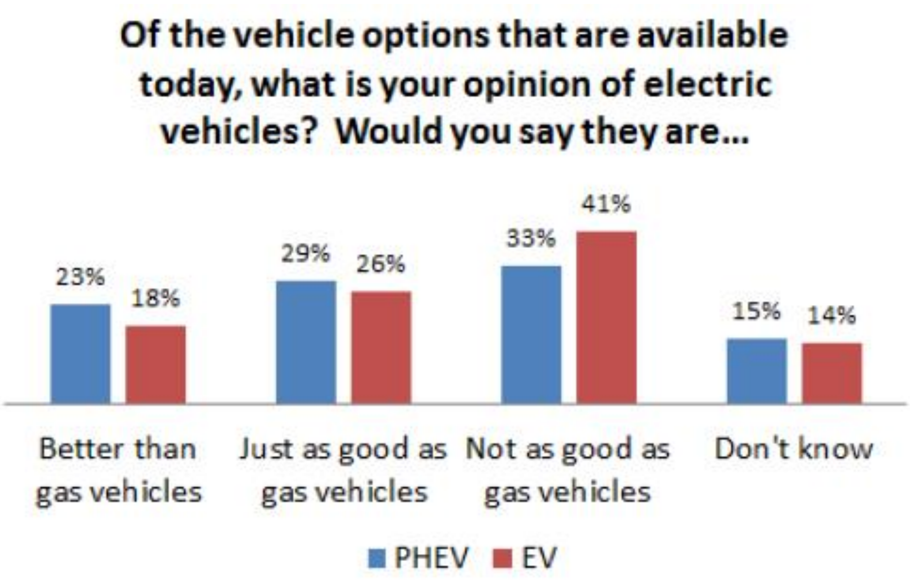
> FOTW: >60% of Millennials and Gen-Xers use the internet to find a car dealer.

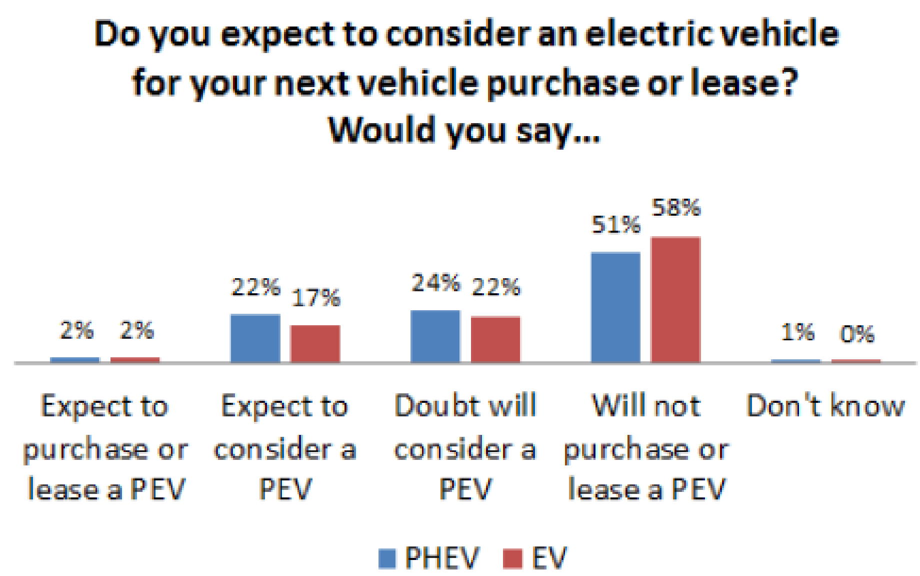
travel behavior

> EIA: On average, households with more vehicles travel more in each/all of those vehicles.

consumer preferences

NREL: Public opinion is split on PEV attractiveness, and the majority are unlikely to even consider a PEV.

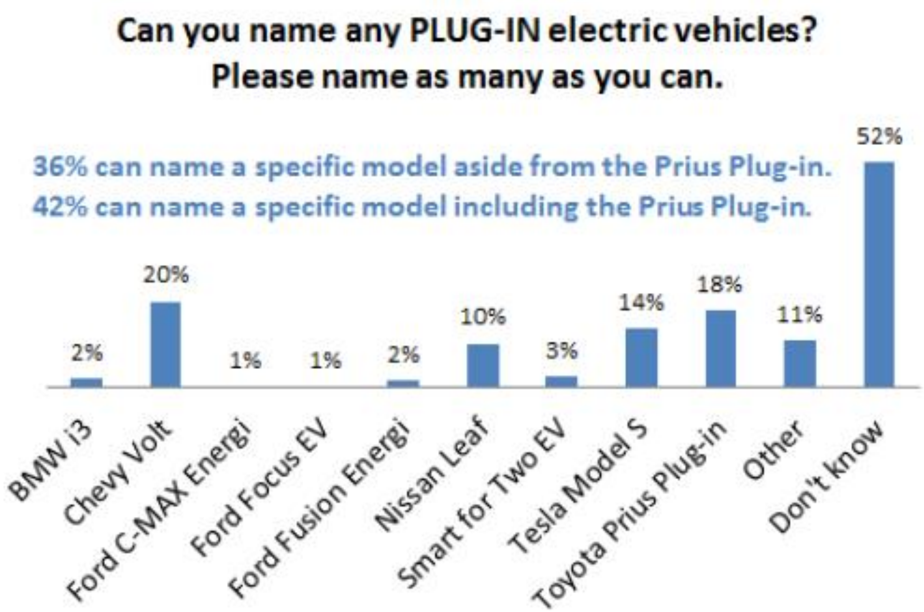


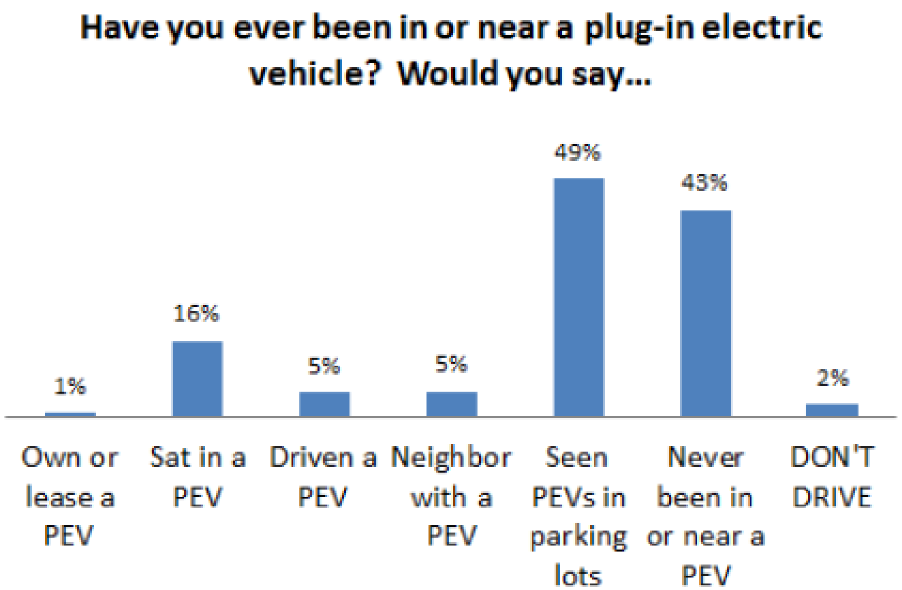


Source: Singer, M. NREL (2015).

consumer preferences

NREL: Most consumers cannot name a PEV model; though, most indicate at least indirect PEV experience.

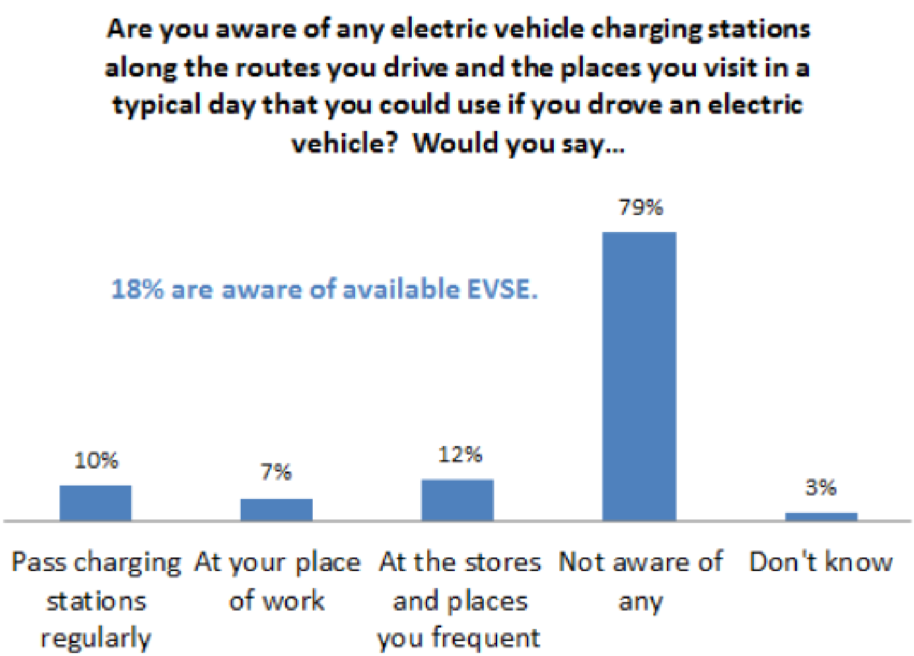


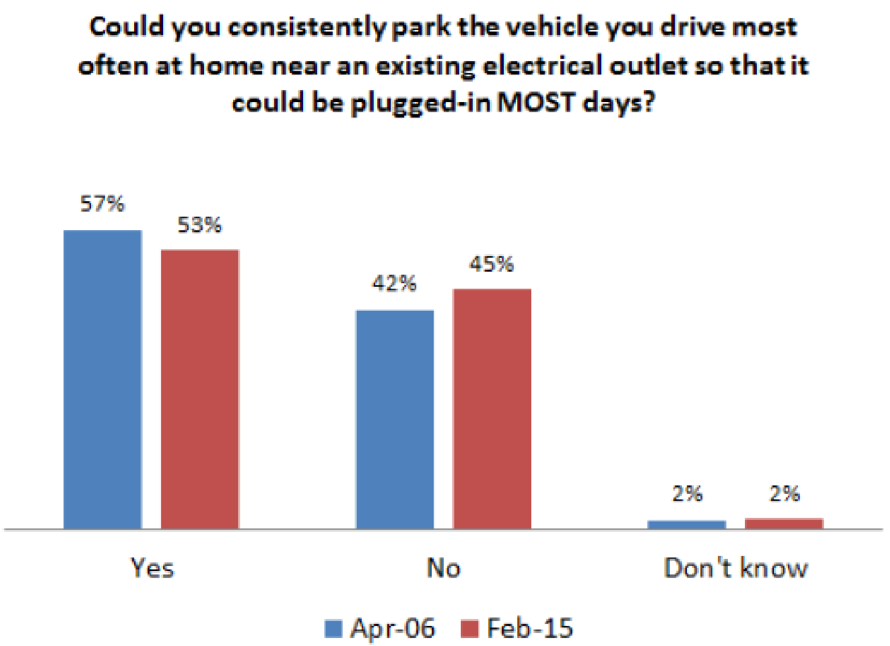


Source: Singer, M. NREL (2015).

consumer preferences

NREL: Most consumers can plug in at home; though, very few are aware of away-from-home charging.

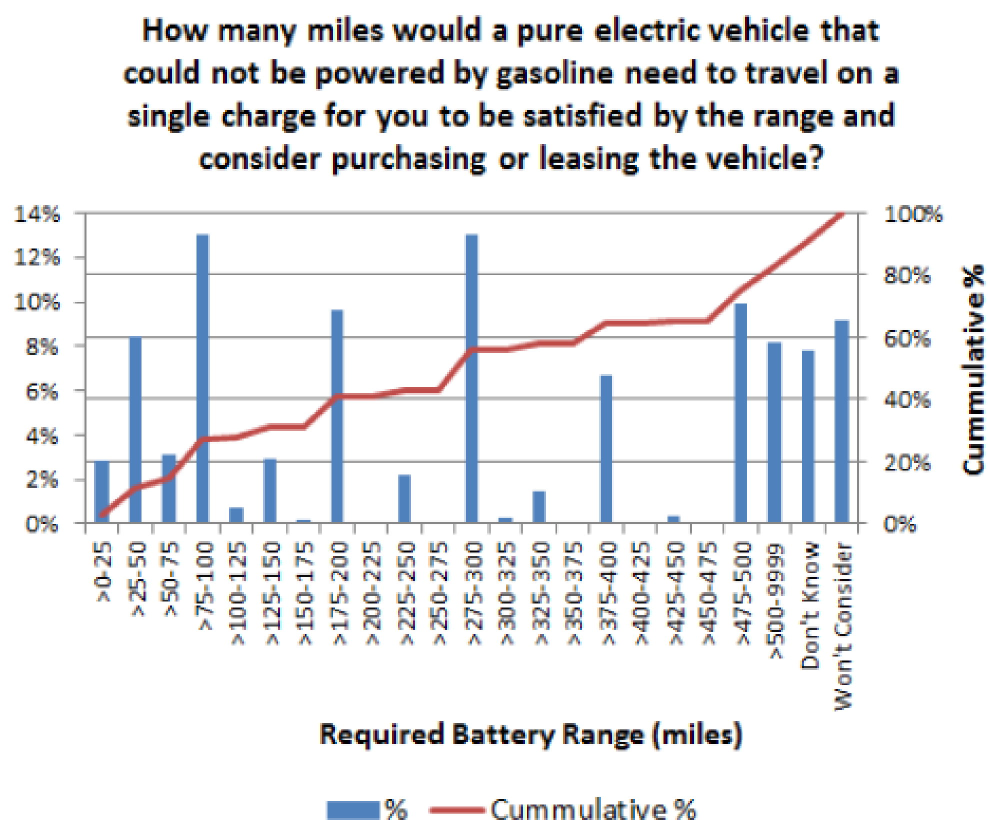




Source: Singer, M. NREL (2015).

consumer preferences

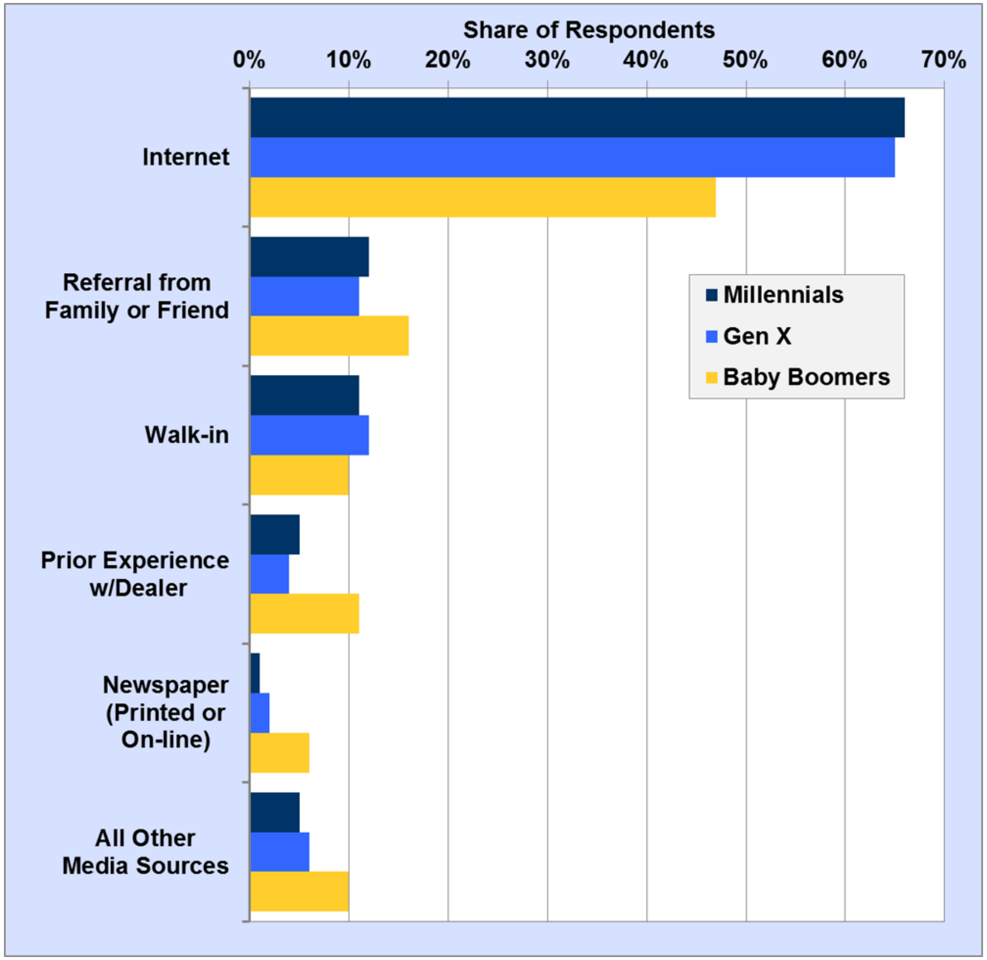
NREL: The median preferred range for consumers to consider purchasing a BEV is 250-300 miles.



Source: Singer, M. NREL (2015).

consumer preferences

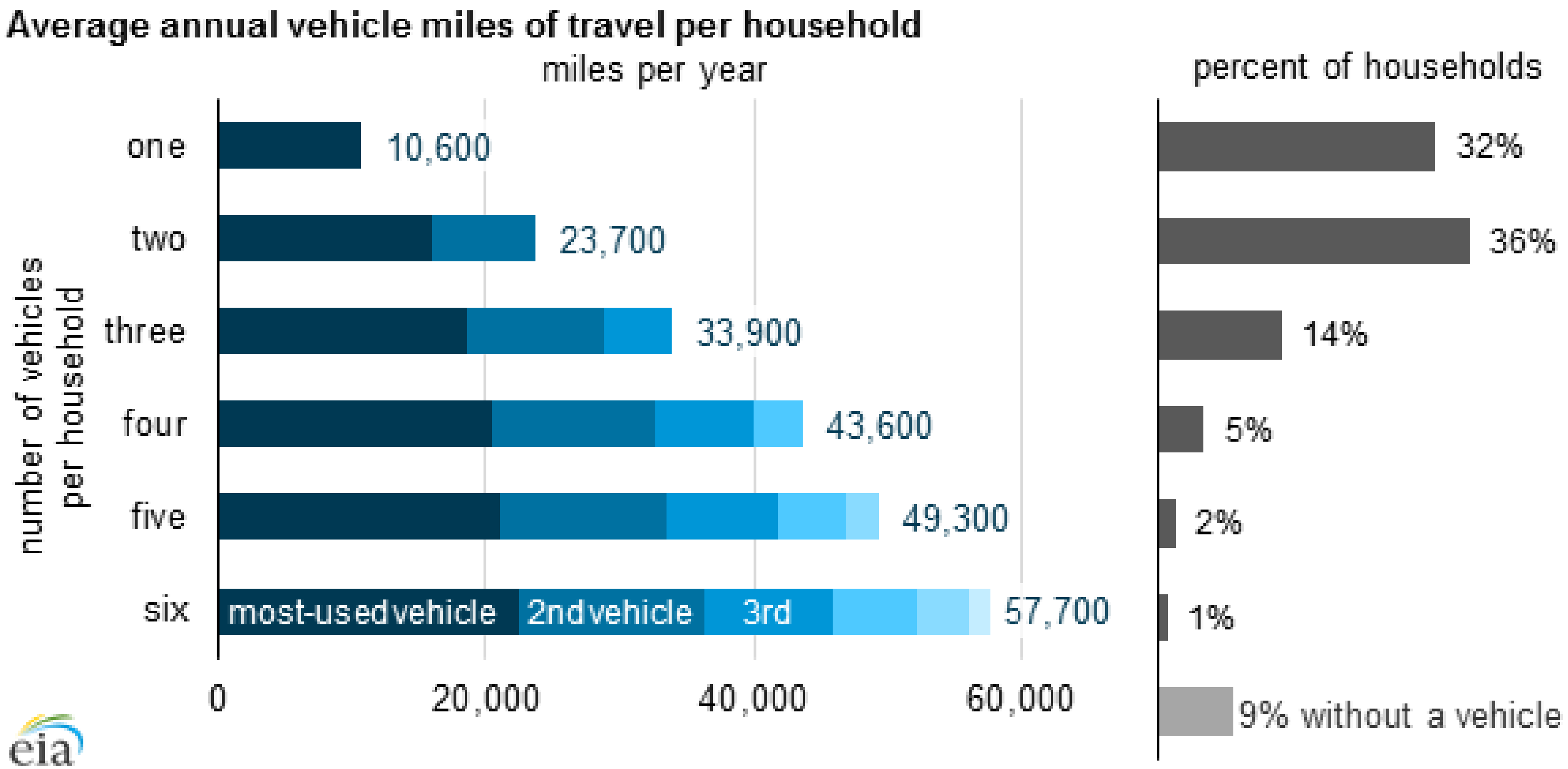
FOTW: >60% of Millennials and Gen-Xers use the internet to find a car dealer.



Source: http://energy.gov/eere/vehicles/fact-872-may-11-2015-study-finds-more-60-millennials-and-generation-xers-use-internet

travel behavior

EIA: On average, households with more vehicles travel more in each of those vehicles.



Source: http://www.eia.gov/todayinenergy/detail.cfm?id=20832

topics

energy markets
automotive markets
technologies studies
environmental studies
consumers/opinion surveys
6 policy studies

qar
outline

6 policy studies

fuel economy regulation

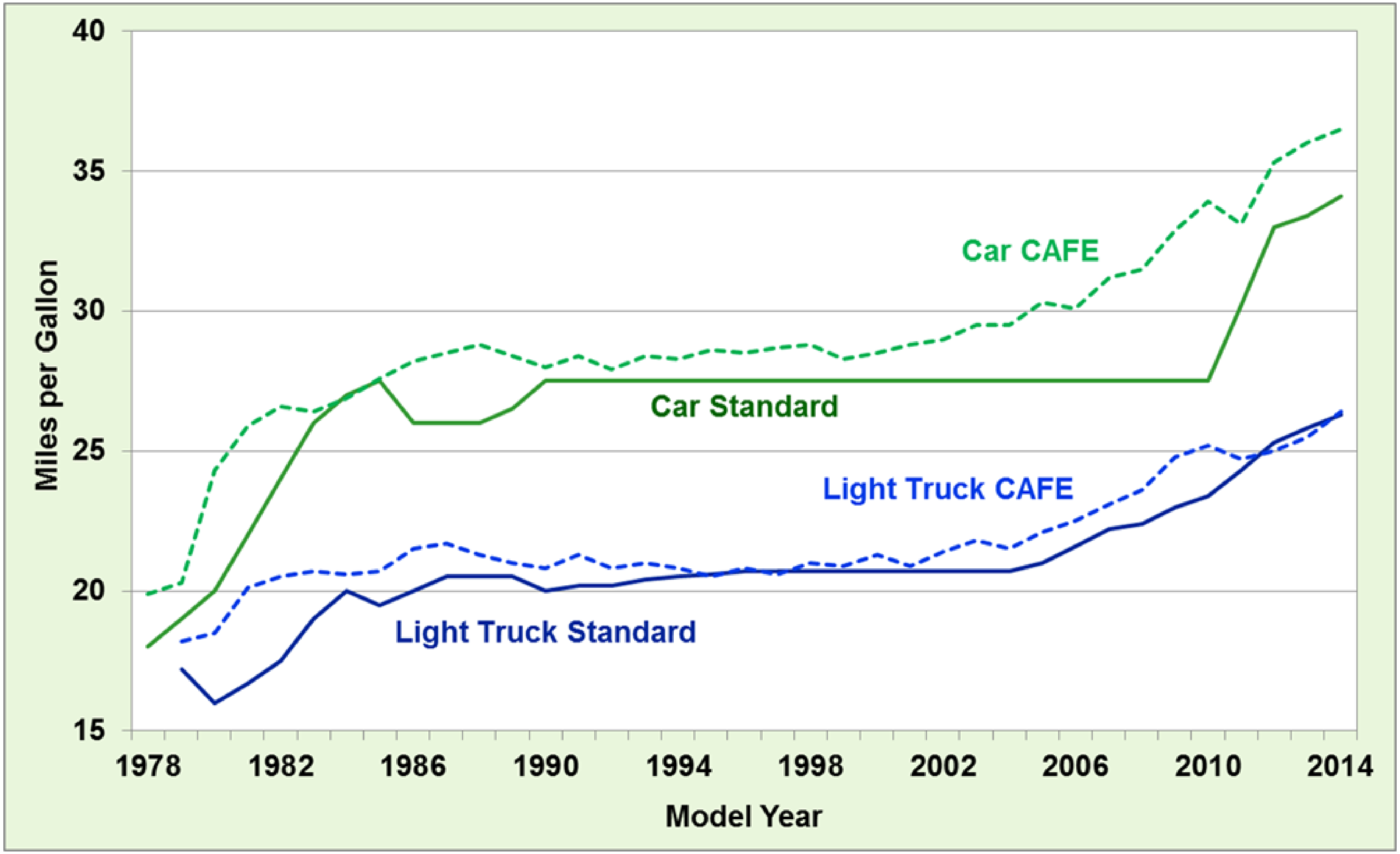
- FOTW: Corporate Average Fuel Economy has increased steadily since mid-2000s.
- FOTW: Most manufacturers have positive CAFE credit balances at the end of MY2013.
- ICCT: HDV standards yield over one million barrels per day of oil savings from 2035–2050.

ev incentives

- ORNL: new database reveals correlations between OEM incentives and MY sales (Volt and Fusion Energi examples).
- ORNL: OEM incentives available for vary by state (Volt and Fusion Energi examples).

fuel economy

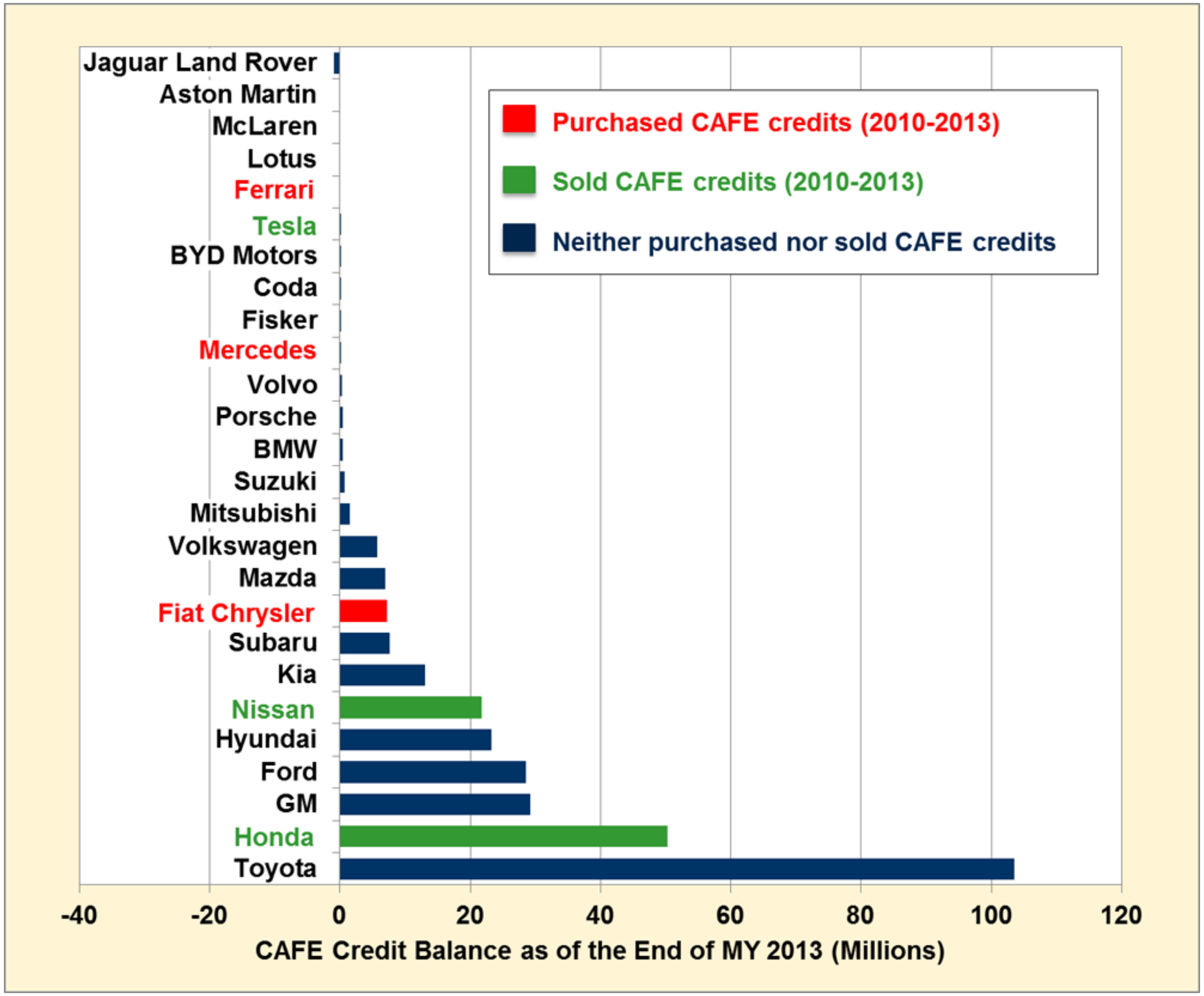
FOTW: Corporate Average Fuel Economy has increased steadily since mid-2000s.



Source: http://energy.gov/eere/vehicles/fact-870-april-27-2015-corporate-average-fuel-economy-progress-1978-2014

fuel economy

FOTW: Most manufacturers have positive CAFE credit balances at the end of MY2013.



Source: http://energy.gov/eere/vehicles/fact-871-may-4-2015-most-manufacturers-have-positive-cafe-credit-balances-end-model

fuel economy

ICCT: HDV standards yield over one million barrels per day of oil savings from 2035–2050.

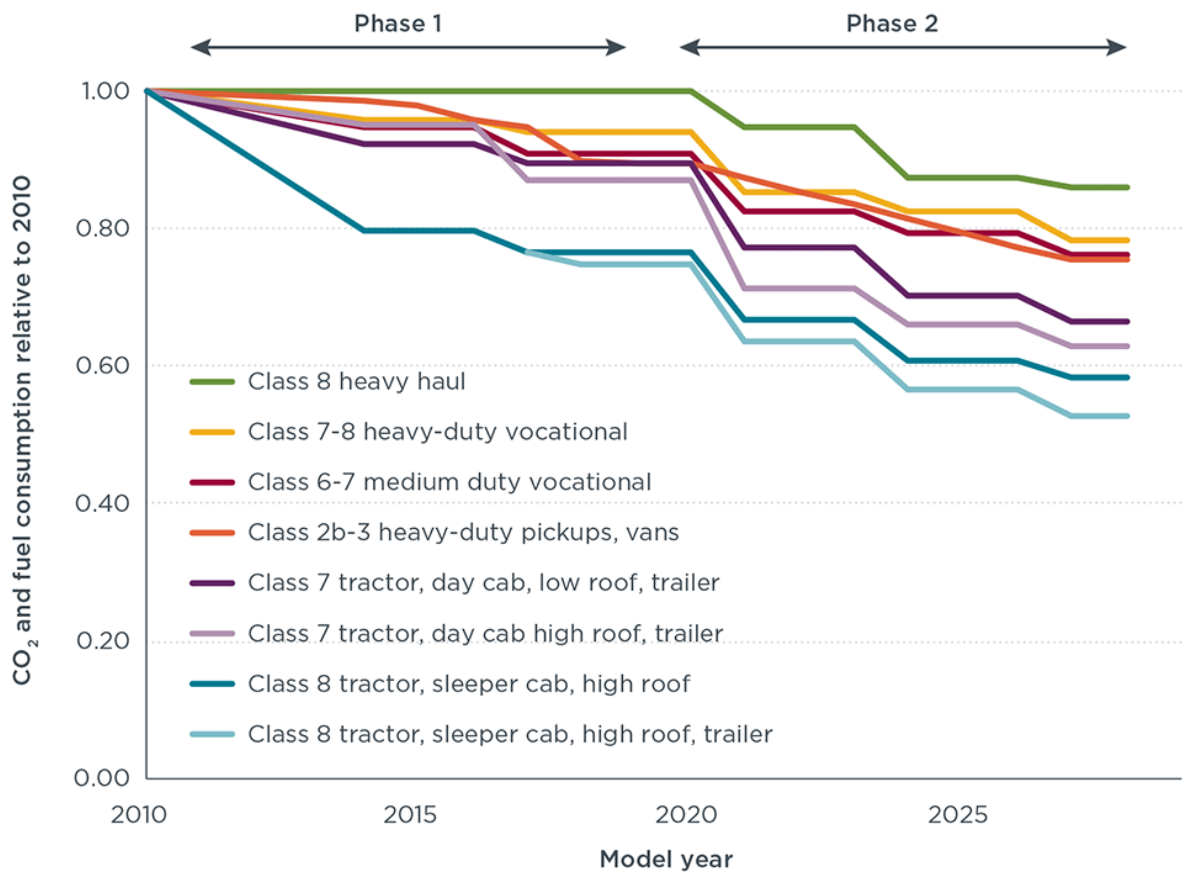
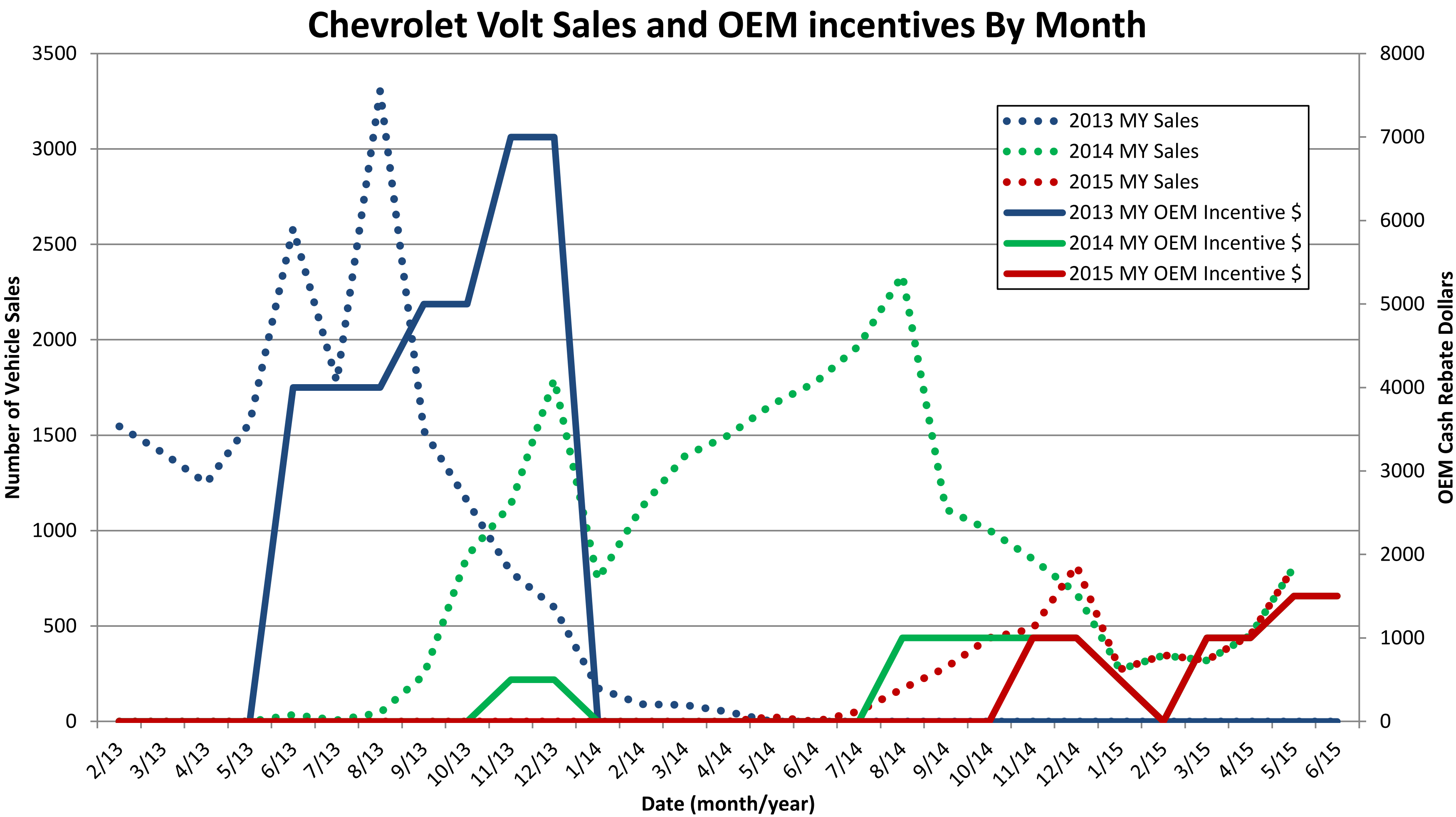


Figure 2. Summary of CO_2 and fuel consumption reduction from adopted Phase 1 and proposed Phase 2 heavy-duty vehicle standards for selected vehicle categories

Source: http://www.theicct.org/us-phase2-hdv-efficiency-ghg-regulations-policy-update

ev incentives

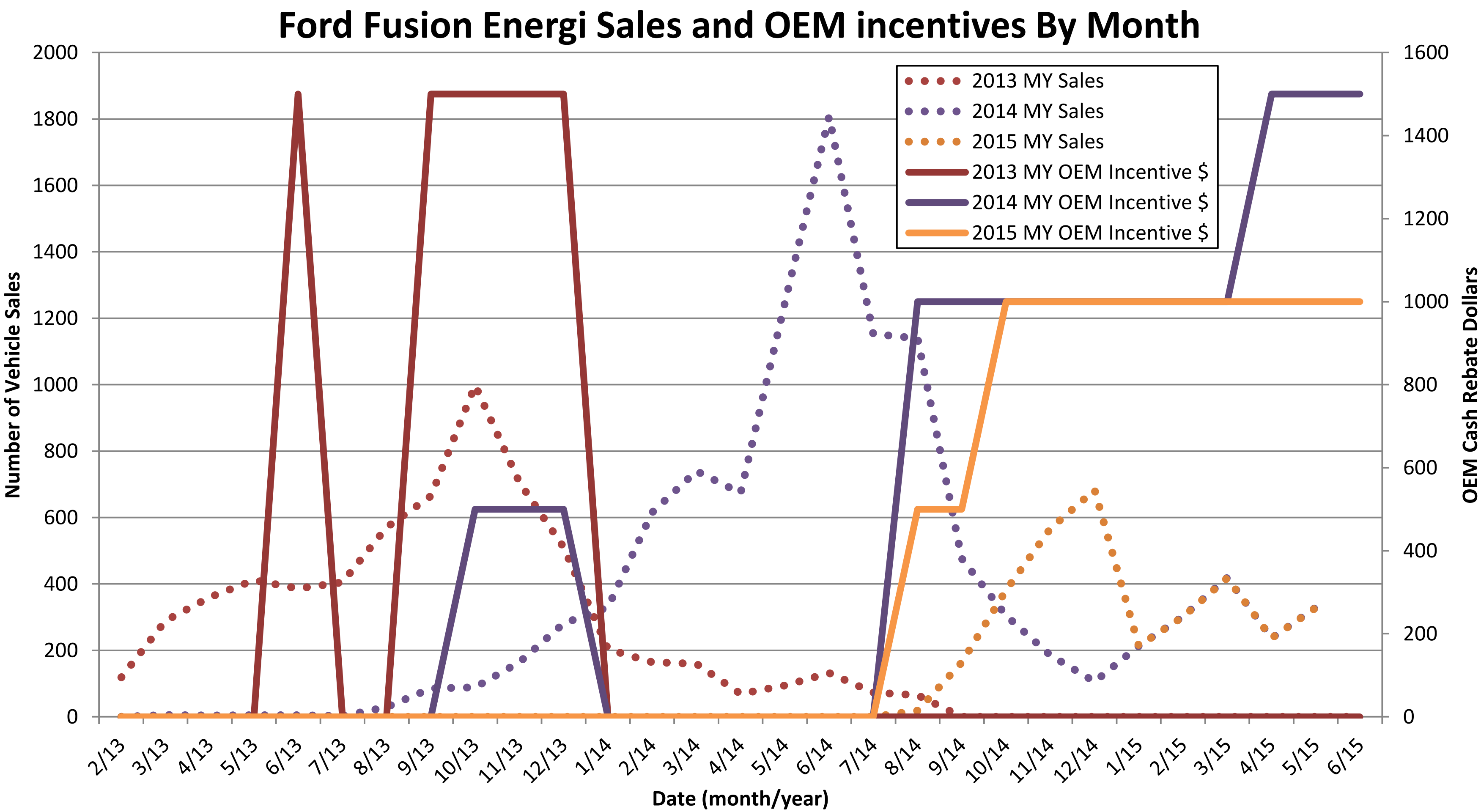
ORNL: new database reveals correlations between OEM incentives and MY sales (Volt example).



Source: Lin, Z. ORNL (2015).

ev incentives

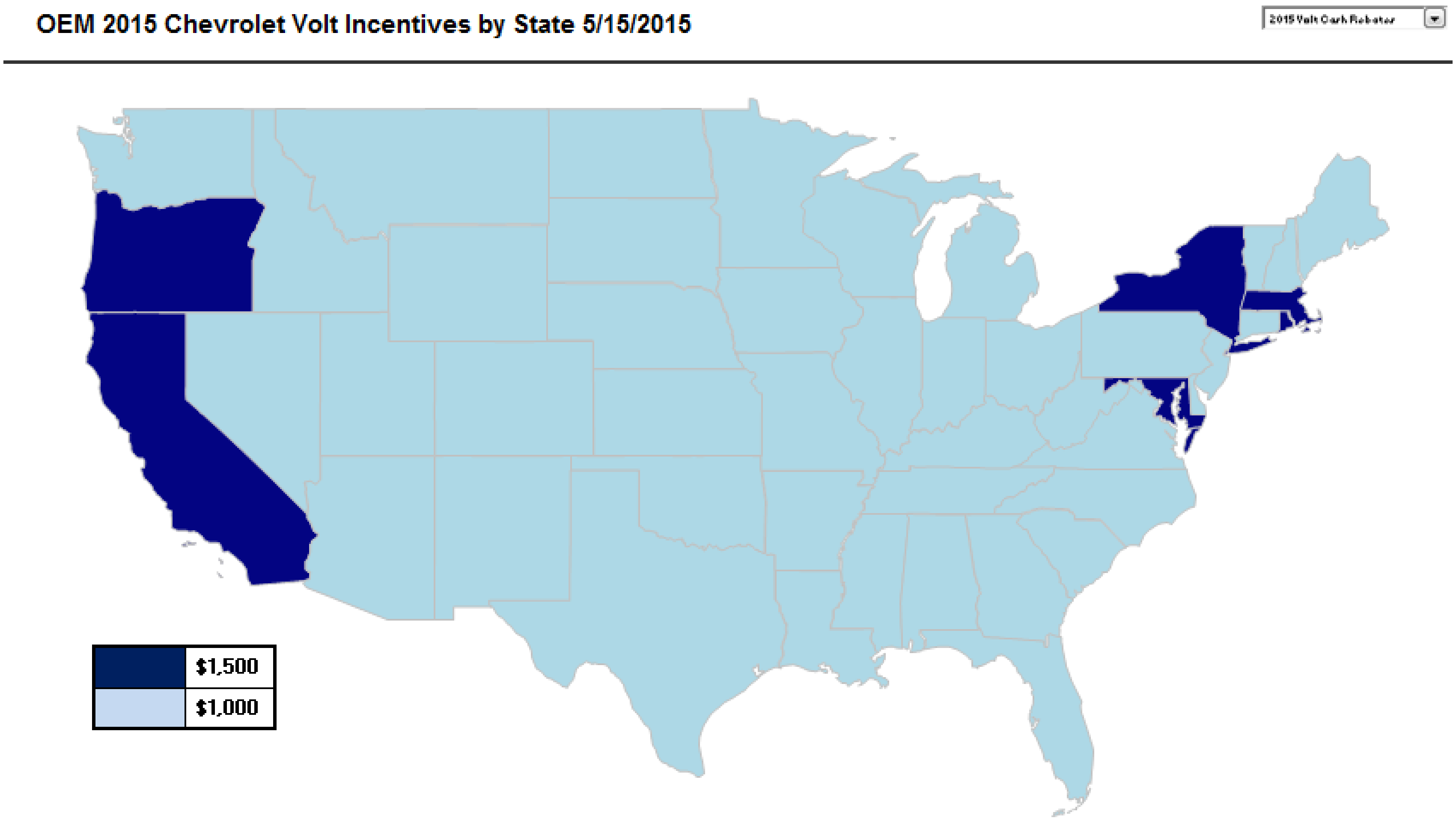
ORNL: new database reveals correlations between OEM incentives and MY sales (Fusion Energi example).



Source: Lin, Z. ORNL (2015).

ev incentives

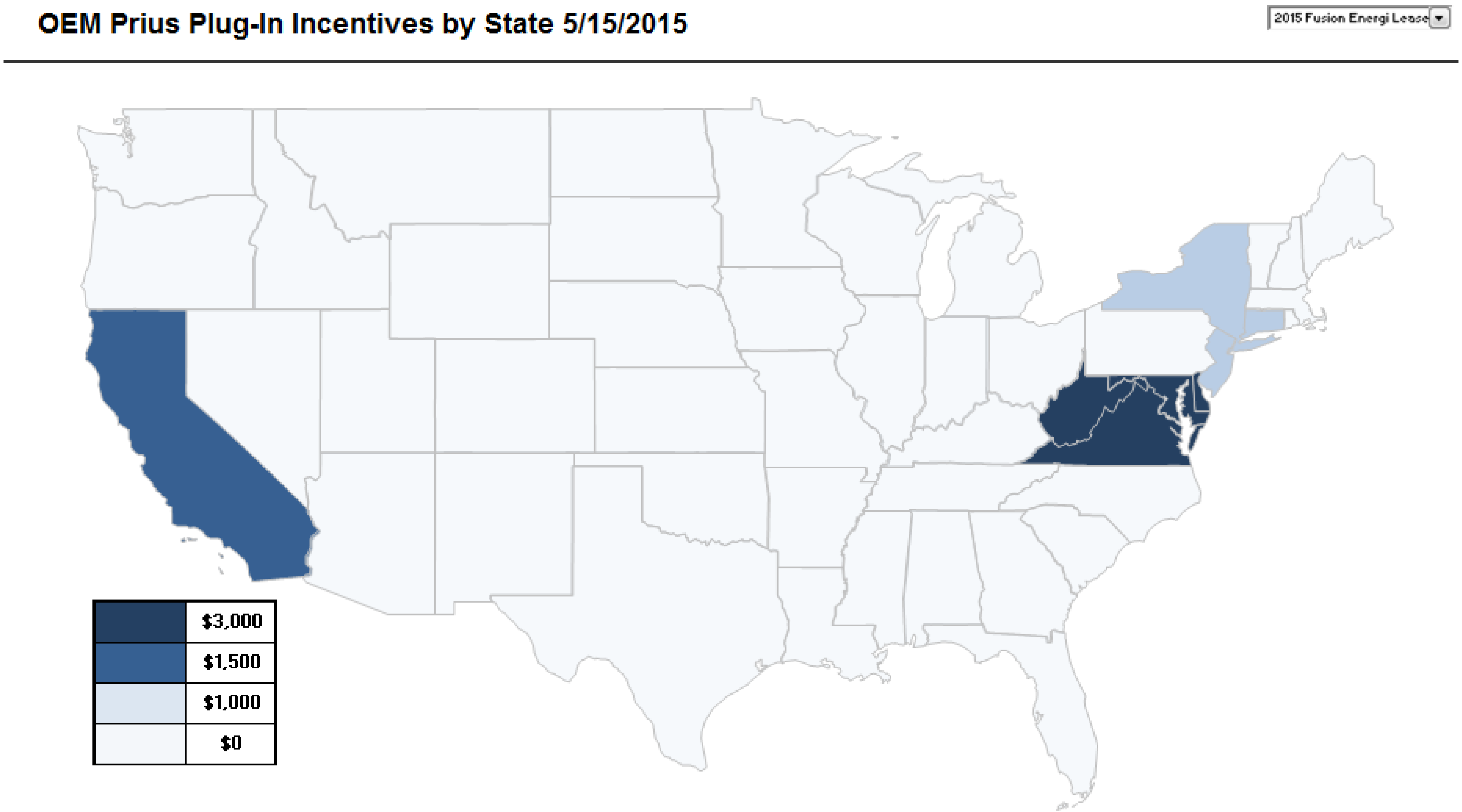
ORNL: OEM incentives available for vary by state (Volt example).



Source: Lin, Z. ORNL (2015).

ev incentives

ORNL: OEM incentives available for vary by state (Prius Plug-in example).



Source: Lin, Z. ORNL (2015).

summary observations

energy oil and gas prices are still at 10-year lows (despite calendar year 2015 rebound), and global energy outlooks are mostly aligned.

automotive PEV sales grew in early 2015 (albeit more slowly); though, PEV markets differ (sometimes greatly) by state.

tech/enviro EPA's Proposed Clean Power Plan offers more certainty to future PEV emissions reductions.

opinion/policy heterogeneity in consumer opinion/motivation along with heterogeneity in both public and private incentives complicates policy and technology considerations.